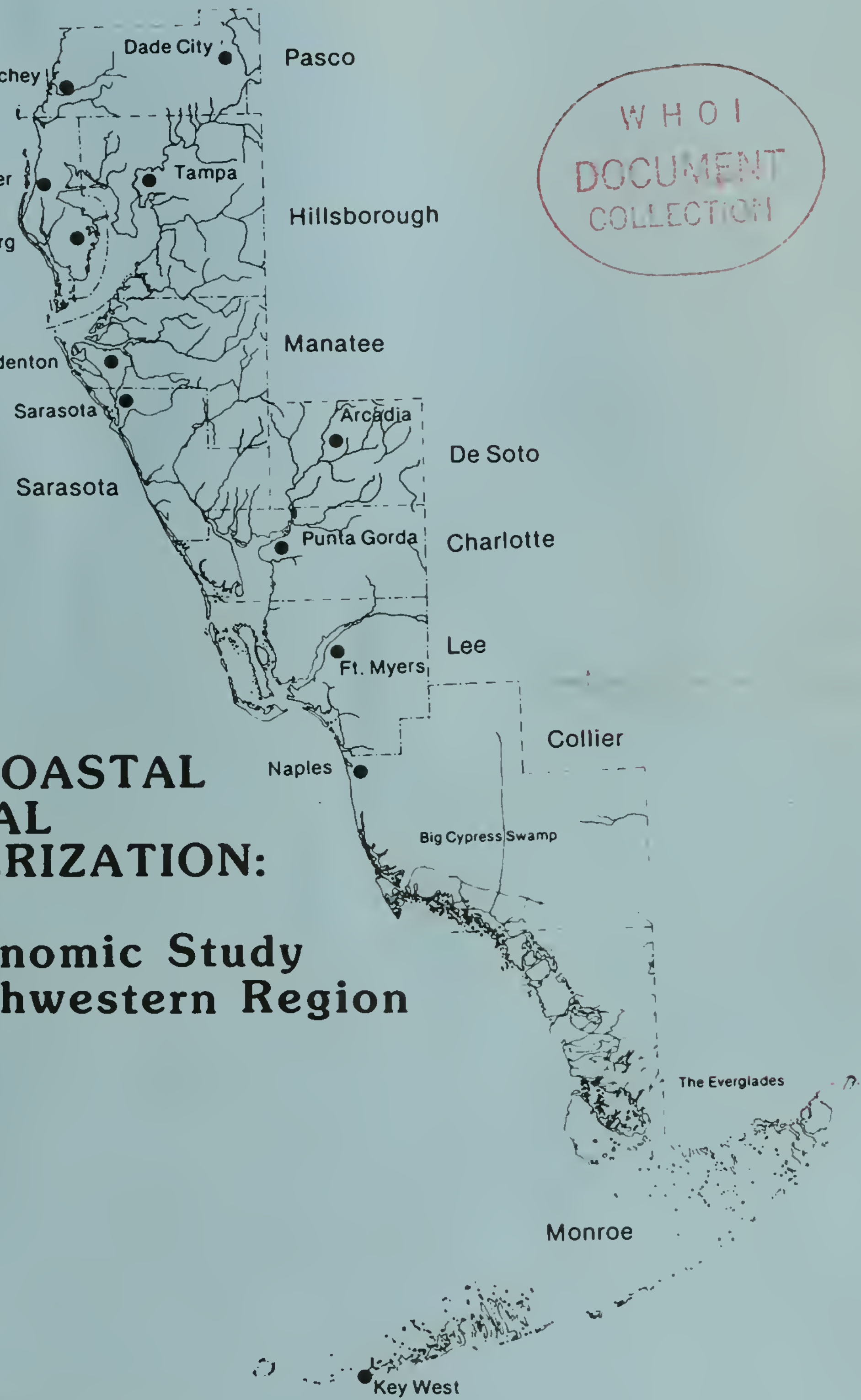
FWS/OBS-83/14
August 1983



FLORIDA COASTAL ECOLOGICAL CHARACTERIZATION:

A Socioeconomic Study of the Southwestern Region

VOLUME I

TEXT

Fish and Wildlife Service

U.S. Department of the Interior

FWS/OBS-83/14
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FLORIDA COASTAL ECOLOGICAL CHARACTERIZATION: A SOCIOECONOMIC STUDY OF THE SOUTHWESTERN REGION

Volume I

TEXT

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This study was co-sponsored by the Minerals Management Service
U.S. Department of the Interior

and the

Division of Biological Services
Fish and Wildlife Service
U.S. Department of the Interior
Washington, DC 20240

PREFACE

The purpose of this socioeconomic characterization study is to compile and synthesize information from existing sources about the social and economic characteristics of the southwestern coastal region of Florida, which is made up of Charlotte, Collier, DeSoto, Hillsborough, Lee, Manatee, Monroe, Pasco, Pinellas, and Sarasota Counties. This report and the data appendix should prove useful for coastal planning and management; it is one in a series of characterizations of coastal socioeconomic systems produced by the U.S. Fish and Wildlife Service. The series describes the components and interrelationships among complex processes that include population and demographic characteristics, mineral production, multiple-use conflicts, recreation and tourism, agricultural production, sport and commercial fishing, transportation, industrial and residential development, and environmental issues and regulations.

This study originally was under contract with the NANEX Systems Corporation, Crestview, Florida. The corporation is responsible for the compilations and accuracy of the Data Appendices and their lists of references. Most of the first drafts of the various chapters were prepared in 1980. Only a few of the sections of some of the reports have since been updated.

This project was conducted under Contract FWS 14-16-0009-074. Funding was provided by the Minerals Management Service and the Fish and Wildlife Service, U.S. Department of the Interior. Questions or requests for this publication should be directed to:

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This report should be cited:

French, Carolyn O., and John W. Parsons (editors). 1983. Florida coastal ecological characterization: a socioeconomic study of the southwestern region. U.S. Fish and Wildlife Service, Division of Biological Services, Washington, D.C. FWS/OBS-83/14.

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INTRODUCTION

This report focuses on the population and demographic characteristics of Charlotte, Collier, DeSoto, Hillsborough, Lee, Manatee, Monroe, Pasco, Pinellas, and Sarasota Counties in Southwest Florida (Figure 1) and examines and analyzes information on population and income characteristics, levels of education, labor, and human services. It also identifies data gaps and inconsistencies.

Since much of this report was written before the 1980 Census data became available, empirical data on population components such as age, race, and sex are lacking. The reliability and validity of the projections for these components in 1980 are subject to error. The accuracy of these estimates is directly related to the degree that the various assumptions are valid for the methodology used.

POPULATION CHARACTERISTICS

STATE OF FLORIDA

From 1950 to 1960, Florida's population growth was faster (79%) than any other state. From 1960 to 1970, the percentage increase was second only to Nevada, and the increase in number was topped only by California.

Florida's 1980 population was 9.7 million, which was 2.9 million or 43% over the 1970 population of 6.8 million (U.S. Department of Commerce, Bureau of the Census 1981). Florida's population is now eighth largest in the Nation.

Florida's population growth has been explosive. In 1950 to 1980, its population increased from 2.7 million to 9.7 million (an increase of more than 250%). The United States was only 45%. Florida's rapid growth is expected to continue. More than 90% of the State's increase population was caused by immigration from other states.

Figure 1. Southwest Florida study region (U.S. Department of the Interior, U.S. Geological Survey 1967).

Most immigrants moved to Florida for employment or retirement. In 1960-1970, retirees, age 65 and over, rose from 11.2% in 1960 to 17.7% in 1980. The national composition was 9% and 11%, respectively. Florida's rapid population growth has brought about a steady increase in employment in the tourist trade, service, and manufacturing industries.

SOUTHWEST FLORIDA

Population Change

The population of Southwest Florida was 2,352,494 (about 24% of the State's total) in 1980 (Table 1). The percent growth far exceeded that of the State in the past 30 years. Florida's population grew 78.7% in 1950-60, (93.8% for Southwest Florida) 37.2% in 1960-70 (40.5% for Southwest Florida) and 43.4% in 1970-80 (52.5% in Southwest Florida). The population of Pinellas County was the largest (728,409) of the ten counties in the region. Charlotte County grew the fastest (1,279%) and DeSoto County grew the slowest (106%). Overall, Southwest Florida's population growth in 1950-80 was 351%; for the State it was 251%. Some of the reasons behind the region's phenomenal growth will be discussed later in the report.

Southwest Florida's growth (natural increase and net migration) in 1950-1980 are shown in the Data Appendix (Tables POP 2, POP 3, and POP 4). Natural increase is calculated as the number of deaths subtracted from the number of births over a given period. Net migration has been the dominant factor affecting growth for the region and State during the past 30 years. Net in-migration is greater for the region than the State. Between 1970 and 1980, net migration accounted for approximately 97% of the region's growth (the remaining 3% was due to natural increase). About 90% of the State's population growth was from net immigration during this same period. Monroe County is the only county where the population growth is not largely attributed to net migration; more than 80% of its growth was from natural increase.

Population Projections

Based upon estimates of future population growth over the next 40 years (Table POP 5 in Data Appendix), a continuing increase in population in Southwest Florida can be expected, especially in Hillsborough and Pinellas counties (Table 2). Monroe, Charlotte, and DeSoto Counties will probably grow the least. In general, Southwest Florida is heavily populated, urban oriented, and fast growing. The population projections (and current estimates) probably miss a large portion of the illegal alien residents in Florida (including Southwest Florida), many of whom are of Hispanic descent. Assuming that there are seven million illegal aliens in the United States now and that an additional five million immigrants will arrive in the 1980's, the minority population (including Hispanics) will increase from about 21% to 26% of the total U.S. population by 1990 (Lewis and Russell 1980). Similar trends, if not stronger ones, are predicted for Florida and Southwest Florida.

Sex, Age, and Racial/Ethnic Characteristics

The methodology used to compute estimates of population in this report assumes that the change in net effect of migration on the age, race, and sex

Table 1. The population and percentage increase in the counties of Southwest Florida at 10-year intervals from 1950 to 1980 (U.S. Department of Commerce, Bureau of the Census 1953, 1963, 1973, 1981; Florida Statistical Abstract 1980).

County	Population				Percentage Increase			
	1950	1960	1970	1980	1950-60	1960-70	1970-80	1950-80
Charlotte	4,286	12,594	27,559	59,115	193.8	118.8	114.5	1,279.3
Collier	6,488	15,753	38,040	85,791	142.8	141.5	125.5	1,222.3
DeSoto	9,242	11,683	13,060	19,039	26.4	11.8	45.8	106.0
Hillsborough	249,894	397,788	490,265	646,960	59.2	23.2	32.0	158.9
Lee	23,040	54,539	105,216	205,266	133.0	92.9	95.1	777.1
Manatee	34,704	69,168	97,115	148,442	99.3	40.4	52.9	327.7
Monroe	29,957	47,921	52,586	63,098	60.0	9.7	20.0	110.6
Pasco	20,529	36,785	75,955	194,123	79.2	106.5	155.6	845.6
Pinellas	159,249	374,665	522,329	728,409	135.3	39.4	39.5	357.4
Sarasota	28,827	76,895	120,413	202,251	166.7	56.6	68.0	601.6
Southwest Florida	566,580	1,097,791	1,542,538	2,352,494	93.8	40.5	52.5	351.2
Florida	2,771,305	4,951,560	6,791,418	9,739,992	78.7	37.2	43.4	251.5

Table 2. Population projections (thousands) for different levels of growth in 1982, 1985, 1990, 2000, and 2020 (Florida Statistical Abstract 1980).

County	Level of growth	1982	1985	1990	2000	2020
Charlotte	low	62.1	66.9	73.7	77.3	97.4
	med	64.0	73.0	86.6	102.1	125.5
	high	66.1	76.9	93.9	117.3	151.3
Collier	low	93.1	100.7	111.6	127.1	149.5
	med	96.2	110.6	132.3	156.7	192.7
	high	99.4	116.5	143.5	180.1	232.4
DeSoto	low	20.4	21.3	22.8	25.1	29.6
	med	20.9	22.7	25.6	29.5	36.4
	high	21.4	23.8	27.5	33.2	42.9
Hillsborough	low	665.4	689.7	724.2	787.4	925.9
	med	682.3	727.9	796.8	900.1	1,106.9
	high	685.4	739.7	825.7	977.9	1,261.8
Lee	low	217.0	232.6	254.6	285.2	335.4
	med	223.1	252.2	296.2	347.5	427.4
	high	229.6	264.1	319.0	395.9	510.8
Manatee	low	151.1	158.6	169.2	186.2	219.0
	med	154.1	168.2	189.4	217.4	267.4
	high	157.3	174.1	200.6	242.3	312.7
Monroe	low	58.6	59.5	60.7	64.6	76.0
	med	58.9	60.4	62.7	68.7	84.4
	high	59.2	61.0	63.9	72.5	93.5
Pasco	low	183.3	198.3	219.5	247.8	291.4
	med	189.1	217.0	259.2	306.8	377.3
	high	195.5	228.8	281.5	352.9	455.3
Pinellas	low	758.4	791.1	837.7	916.5	1,077.7
	med	771.5	833.0	925.9	1,055.0	1,297.4
	high	785.4	858.6	974.6	1,166.3	1,504.9
Sarasota	low	208.7	221.0	238.4	264.3	310.8
	med	213.6	236.7	271.4	1314.5	1386.7
	high	218.7	246.0	289.3	1353.7	1456.4
Southwest Florida	low	2,418.1	2,539.7	2,712.4	2,987.1	3,512.7
	med	2,473.7	2,701.7	3,046.1	3,498.3	3,915.4
	high	2,518.0	2,789.5	3,219.5	3,892.1	5,022.0

components of a county's population in 1970-80 was similar to that of 1960-70. Lewis (1980) rationalizes this approach rather than using current symptomatic data.

Sex composition. The 1950 Census of the ten counties of Southwest Florida showed that females comprised approximately 53% of the population (Table POP 6, Data Appendix). This edge by females probably will hold true for the next 40 years (Tables POP 7, POP 8, and POP 9, Data Appendix).

Age groups. In Southwest Florida in 1960, residents under age 18, between 18 and 63, and older than 63 consitituted 43%, 41%, and 16% of the population, respectively. In 1970 the percentages were 26, 52, and 22. (U.S. Department of Commerce 1963, 1973). In general, the percentage of older people in the population has increased, with the possible exception of Hillsborough County (Florida Statistical Abstract 1980). In short, Southwest Florida has an abundance of older adults (45 years and older) and lesser numbers of young people in the prime working age group (ages 25-44). The five counties in Southwest Florida with high percentages of senior citizens are Charlotte (41.1%), Sarasota (35.3%), Pasco (32%), and Manatee (31.9%).

Southwest Florida's age structure is different from that of the State for several reasons. Retired people rely heavily on outside income in the form of investments, social security, or welfare payments, i.e., an important part of the income is from Federal transfer payments. Secondly, the age structure influences the level of demand for locally provided services, and thirdly, if an area is to expand economically, there is a need for adequate labor and skills; therefore, emigrating young adults and parents of young children in response to employment opportunities elsewhere could slow down economic expansion in Florida.

RACIAL/ETHNIC COMPOSITION

Blacks are the predominant minority group in Southwest Florida (Table 3). In 1980, Blacks, American Indians, Eskimos, Aleuts, and Asian and Pacific Islanders comprised 10% of the population (compared to 14% in the State). The 10% minority composition declined 4% between 1970 and 1980. Exactly what caused the decline is difficult to ascertain because the 1980 data are not yet available. It is safe to say, however, that based upon population estimates during the 1960's (Bowles and Tarver 1965), Hillborough, Lee, and Pinellas Counties received a a majority of the minority immigrants in Southwest Florida.

The 1980 census for the "White" and "other" racial categories are not comparable to the 1970 census. The explanation stems primarily from the way Hispanics reported their race in the 1980 census. Nationwide, a larger portion (40%) of the people of Spanish origin did not report belonging to a specific race and have thus been included in the "other" category. Another 56% said they were white (U.S. Department of Commerce, Bureau of the Census 1981). Similar changes are reflected in the reporting by persons of Spanish origin in the categories of "White" and "other" in both the State and Southwest Florida. Overall, persons of Spanish origin represent 4.6% of the population in Southwest Florida, and 8.8% for the State as a whole (Table 3).

Table 3. The population of ethnic/racial minority groups in the counties of Southwest Florida in 1980 (U.S. Department of Commerce, Bureau of the Census 1981).

County	Total population	White	Minorities				Ethnic[a]
			Black	American Indians, Eskimos, Aleuts	Asian/Pacific Islanders	Other	Spanish origin
Charlotte	59,115	57,445	1,115	67	304	173	684
Collier	85,791	74,481	4,550	174	196	6,390	9,255
DeSoto	19,039	15,155	3,557	33	55	239	610
Hillsborough	646,960	546,575	86,464	1,337	3,833	8,751	64,199
Lee	205,266	185,467	16,321	223	586	2,669	5,718
Manatee	148,442	133,191	13,263	259	405	1,324	3,185
Monroe	63,098	57,855	3,802	143	624	674	7,155
Pinellas	728,409	666,830	55,206	993	3,134	2,246	10,526
Pasco	194,123	187,515	4,031	423	433	1,721	4,704
Sarasota	202,251	189,711	10,457	272	704	1,107	2,989
Southwest Florida	2,352,494	2,114,255 (90%)	198,766 (8%)	3,924 (0.2%)	10,274 (0.7%)	25,294 (1.1%)	109,025 (4.6%)
Florida	9,739,992	8,178,387 (84%)	1,342,478 (14%)	19,316 (0.2%)	56,756 (0.4%)	143,055 (1.4%)	857,898 (8.8%)

[a]Persons of Spanish origin may be of any race. Thus, figures shown in this category are already enumerated in the categories indicating minorities and white. Persons of Spanish origin represented 4.6% of Southwest Florida's population distribution in 1980 compared to 8.8% for the State.

POPULATION GROWTH, TRENDS, AND SHIFTS

Although Florida's population growth since 1950 has been a rapid one, annual growth rates have varied considerably. Annual growth was about 5% in the early 1950's, 8% in the late 1950's, 3% in the late 1960's, 5% in the early 1970's, less than 2% in the mid 1970's, and 3% in 1979 (Florida Chamber of Commerce 1979).

An analysis of the population growth for Southwest Florida (data for 1950-60, 1960-70, and 1970-80 are given in Tables POP 2, POP 3, and POP 4) shows that the growth in 1950-60 was high (93.8%) compared to the State as a whole (78.7%).

A sharp slowdown in the average growth was apparent in the early 1960's. The average growth rate in Southwest Florida fell 53.3% (from 93.8% to 40.5%), whereas the State rate dropped 41.5% (from 78.7% to 37.2%). In the 1970's the average growth rate in Southwest Florida rose 12% (from 40.5 to 52.5%), but the State growth rate changed little (37.2% to 36.1%).

In summary, the population of Southwest Florida increased rapidly in 1950-60, slowed down in 1960-70, and increased in the 1970's. The increase in the 1970's was largely due to the massive influx of senior citizens.

INCOME CHARACTERISTICS

INCOME LEVELS

Per capita income is an excellent measure of an area's economic position. Personal income reflects levels of pay and skill in local industries, unemployment patterns, and participation of residents in the labor force. Southwest Florida lagged behind the State's per capita income from 1950-70 by about $100; but more recently (1978) the gap narrowed (Table 4). Income in Collier, Monroe, Pinellas, and Sarasota Counties (where per capita income exceeds the State average) have the largest incomes which is why the Southwest Florida per capita income is rapidly approaching that of the State. Low per capita income for the other six counties is probably caused by high seasonal unemployment and a growing retirement population.

The median family income for Southwest Florida was $2,154 in 1950 and $4,322 in 1960, an increase of more than 100% (Table 5). In 1960-69 the median income level increased 73% (from $4,322 to $7,488) and in 1970-79, it rose from $7,488 to $14,000, an 87% increase. These figures match well with the State median family income in 1950-79. For example, the median income in 1950 for Southwest Florida was $2,400, but in 1960, the Southwest Florida median income was $4,322, somewhat less than the State median of $4,720. In 1969, the median family income gap between Southwest Florida and the State widened even more. The $7,488 income in Southwest Florida was $773 less than that for the State ($8,261). In 1979, the median family income in Southwest Florida was $14,000 and for the State it was $17,558.

Table 4. Per capita income ($) for 1950, 1960, 1970, and 1978 (Florida Statistical Abstract 1962, 1977, 1980; Bureau of Economic and Business Research 1980).

County	1950	1960	1970	1978
Charlotte	947	1,463	3,345	7,099
Collier	1,684	2,261	5,196	9,061
DeSoto	1,058	1,383	2,647	6,514
Hillsborough	1,289	1,910	3,357	6,955
Lee	1,235	1,763	3,540	7,010
Manatee	882	1,419	3,294	7,315
Monroe	1,416	2,567	3,398	8,009
Pasco	1,209	1,290	2,977	5,559
Pinellas	1,248	1,905	3,854	7,899
Sarasota	1,473	2,272	4,697	9,130
Southwest Florida[a]	1,262	1,847	3,630	7,500
Florida	1,314	1,988	3,738	7,578

[a]Per capita income for the region was computed by multiplying the per capita income in each county by the population of that county, then aggregating the products for all 10 counties, and dividing the aggregate by the region's total population.

Table 5. Median family income ($) for the counties of Southwest Florida in 1950, 1960, 1969, and 1979 (U.S. Department of Commerce 1953, 1963, 1970, and 1980).

County	1950	1960	1969	1979
Charlotte	1,750	3,918	6,255	11,500
Collier	2,189	4,673	9,136	17,400
DeSoto	2,060	3,542	6,320	11,500
Hillsborough	2,381	4,616	8,162	14,300
Lee	2,119	4,286	7,878	14,400
Manatee	1,917	3,814	6,591	12,300
Monroe	2,731	4,660	7,334	13,700
Pasco	1,807	3,307	4,998	14,300
Pinellas	2,441	4,359	7,642	14,300
Sarasota	2,436	4,688	7,739	14,400
Southwest Florida[a]	2,154	4,322	7,488	14,000
Florida	2,400	4,720	8,221	17,558

[a]The median income for Southwest Florida was computed from the region's income distribution (derived by aggregating the distributions for the ten counties).

Charlotte and DeSoto Counties have the lowest median family income in Southwest Florida. The largest income increase over the past 29 years were in Collier County (645%) and in Pasco County (691%) where a high percentage (33%) of elderly citizens in the population was probably a major factor contributing to the increase.

POVERTY INDEX

The poverty rate (less than $3,968 income per capita) for Florida and Southwest Florida was 13%. About 17% of the families in the State and 14% in Southwest Florida had incomes exceeding $15,000 (Table 6). Collier County had the largest percentage (25%) of families earning $15,000 or more per annum, whereas only about 6% of the families in Pasco County earned $15,000 or more. About 77% of the families in Southwest Florida earned about $4,000 to $14,999 per year.

Another indicator of poverty is the number of persons receiving Aid for Families with Dependent Children (AFDC) benefits and food stamps. About 12% of the families receiving AFDC funds in Florida in 1978-79 resided in Southwest Florida (Florida Department of Health and Rehabilitative Services 1979).

Table 6. Percentage of the population in Southwest Florida in different levels of income in 1970 (U.S. Department of Commerce, Bureau of the Census 1972).

County	Less than $3,968	$3,968 to 14,999	$15,000 or more
Charlotte	10.4	79.0	10.6
Collier	11.1	63.7	25.2
DeSoto	17.2	74.4	8.4
Hillsborough	12.8	73.2	14.0
Lee	11.9	73.1	15.0
Manatee	13.4	75.6	11.0
Monroe	14.0	73.6	12.4
Pasco	17.5	76.7	5.8
Pinellas	9.0	76.6	17.0
Southwest Florida	12.9	73.2	13.9
Florida	12.7	70.5	16.8

EDUCATIONAL ATTAINMENT

Educational attainment provides an index of an area's potential occupational skills. An overview of the educational attainment of residents in the Southwest Florida are given in Tables POP 11-12 in the Data Appendix. Data are given for persons 25 years old and over who received no schooling, and for those who attended school. The median school years completed from 1950 to 1970 was about the same for Southwest Florida and for Florida as a whole. Non-Whites are considerably less educated than White residents. Southwest Florida appears to have an adequate number of public K-12 schools, teaching staff, and enrollees. The region has about 25% of the State's population, but only 20% of the educational facilities (Table 7).

Current enrollment in such education programs as Adult Basic Education, (ABE) although not outstanding, are similar to those across the State (Table 8). This program and other similar programs potentially can help overcome illiteracy and increase occupational skills. Major educational institutions in the region can also have a stabilizing influence on the economy.

THE LABOR FORCE

LABOR FORCE CHARACTERISTICS

The number of males and females in the labor force and the percentage unemployed are shown in Table 9; those employed in manufacturing, white collar occupations, and government jobs are shown in Table 10. An analysis of the 1970 data shows that the percentage of male laborers 18 to 24 years old in Southwest Florida exceeded that for the State (85% compared to 75%). Both areas had virtually the same percentage of government workers (about 16%). The percentage of females 16 years and older, married women (husband present), males 65 years old and over, and employed persons in industries and white collar occupations was below that of the State (Table 9). The percentage of the available work force that is employed in different occupations is given in Table 10.

Both the State and Southwest Florida had the same unemployment rate (3.8%) in 1970 and in 1982 (7.1%; Table 11). The county in Southwest Florida with the highest unemployment in 1982 was Collier (9.2%), followed by Charlotte County (8.2%) and Pasco County (7.8%). Manatee and Pinellas Counties shared lowest unemployment (5.9%).

The number and percentage of women in the labor force increased rapidly in the 1970's and will probably continue to increase in the 1980's. In recent years, many women have taken jobs to supplement the family income to offset inflation, or support themselves and their children. The number and percentage of men and women employed in the counties of Southwest Florida in 1950, 1960, and 1970 are given in Table 12.

Despite smaller families, an increased sense of family sharing and the growing equality of education and employment opportunities for women, some substantial differences between male and female employment still persist. For example, relatively few women with young children enter the labor market. The

Table 7. Education data for number of public K-12 schools, students, full-time staff, high school graduates, value of property, expenditures, number of non-public schools and non-public school students in FY 1978-79 (Florida Department of Education 1980a).

County	Number of public K-12 schools[a,b]	Number of students K-12[a]	Number of full-time staff[a,b,c]	Number high school graduates[a]
Charlotte	11	5,729	662	359
Collier	23	12,244	1,437	1,340
DeSoto	8	3,160	389	154
Hillsborough	138	99,560	11,690	5,433
Lee	42	25,497	3,005	1,482
Manatee	30	18,298	2,362	1,019
Monroe	17	7,781	1,033	518
Pasco	33	20,469	2,342	1,243
Pinellas	166	79,018	8,315	5,467
Southwest Florida	447	293,709	33,369	18,790
Florida	2,256	1,367,298	147,939	88,519

County	Assessed value of property	Total expenditures all funds	Number of non-public schools[d]	Number of non-public students
Charlotte	884,826,839	13,388,693	4	477
Collier	1,998,379,143	32,482,008	7	1,131
DeSoto	228,653,975	9,295,306	2	133
Hillsborough	6,006,819,180	218,660,416	66	14,554
Lee	2,952,711,920	67,072,358	11	2,177
Manatee	2,322,358,476	43,192,561	10	1,707
Monroe	1,096,849,475	17,912,225	9	906
Pasco	1,520,866,337	49,613,717	8	434
Pinellas	7,239,807,280	179,770,933	49	11,907
Sarasota	3,595,994,777	49,953,397	14	2,094
Southwest Florida	27,847,267,402	681,341,614	180	35,520
Florida	117,592,872,456	2,962,686,564	871	176,601

[a]County tabulations subject to error.
[b]Includes adult schools.
[c]Fall, 1978.
[d]Grades 1-12.

Table 8. Adult basic education (ABE) enrollment by race and age 65 and over for FY 1978-79 (Florida Department of Education, Division of Community Colleges 1980b).

County	White Non-Hispanic		Black Non-Hispanic		Hispanic	
	Male	Female	Male	Female	Male	Female
Charlotte	1,962	3,117	17	43	17	50
Collier	886	2,276	81	192	149	203
DeSoto	355	512	199	266	48	15
Hillsborough	9,954	11,657	3,993	4,362	2,067	1,962
Lee	1,640	3,838	205	397	75	75
Manatee	805	944	185	551	42	63
Monroe	541	684	76	92	153	218
Pasco	2,606	13,066	151	336	74	128
Pinellas	4,140	4,403	2,380	2,670	254	333
Sarasota	1,289	1,570	245	357	72	94
Southwest Florida	24,178	42,067	7,532	9,266	2,951	3,141
Florida	96,818	147,131	34,506	43,621	25,806	38,817

County	Asian/Pacific Islander		American Indian/ Alaskan Native		65 and over	Total
	Male	Female	Male	Female		
Charlotte	9	16	N.D.	N.D.	3,087	5,231
Collier	7	15	3	4	381	3,816
DeSoto	3	4	N.D.	N.D.	15	1,402
Hillsborough	508	614	191	198	3,653	35,506
Lee	20	73	2	25	901	6,350
Manatee	15	25	N.D.	N.D.	21	2,630
Monroe	13	70	N.D.	1	31	1,848
Pasco	16	40	1	1	4,688	16,419
Pinellas	271	490	35	36	384	15,012
Sarasota	43	64	10	4	494	3,748
Southwest Florida	905	1,411	51	269	13,655	91,962
Florida	3,106	4,208	757	990	50,081	395,810

Table 9. Percentage of the different sexes and age groups in the labor force in Southwest Florida and the rate of unemployment in 1970 (U.S. Department of Commerce).

County	Sex and age				Civilian labor force
	Females 16 years and older	Married women husband present	Male		
			18 to 24 years	65 & over	Percentage unemployed
Charlotte	22.0	19.7	86.3	7.8	3.1
Collier	37.8	33.5	80.4	20.4	2.6
DeSoto	36.7	44.0	71.3	17.6	3.5
Hillsborough	41.0	39.49	75.7	22.1	3.7
Lee	35.2	32.4	78.5	15.2	3.2
Manatee	28.6	26.0	81.0	8.6	2.8
Monroe	36.5	33.2	91.9	19.1	4.3
Pasco	21.5	19.0	60.4	7.3	4.8
Pinellas	31.3	29.2	76.7	10.4	3.5
Sarasota	29.5	26.5	73.3	9.6	2.2
Southwest Florida	33.5	34.0	85.1	15.6	3.75
Florida	39.1	36.9	75.4	17.5	3.8

Table 10. Percentage of the available work force working in different occupations in 1970 (U.S. Department of Commerce 1972).

County	Occupation: Manufacturing	Clerical or white coller	Government positions	Other
Charlotte	5.9	46.4	13.4	34.3
Collier	3.7	45.3	11.2	39.8
DeSoto	7.2	29.4	31.9	31.5
Hillsborough	17.5	48.1	14.3	20.1
Lee	5.3	48.1	13.2	33.4
Manatee	14.1	45.2	13.5	27.2
Monroe	3.9	49.5	25.7	20.9
Pasco	3.9	49.5	25.7	20.9
Pinellas	17.1	39.8	11.2	31.9
Sarasota	9.3	52.6	11.8	
Southwest Florida	8.4	45.4	16.2	30.0
Florida	14.1	49.8	16.0	20.1

Table 11. Percentage unemployed in Southwest Florida in April, 1982 (U.S. Department of Labor, Bureau of Labor Statistics 1982).

County	Percentage
Charlotte	8.2
Collier	9.2
DeSoto	7.4
Hillsborough	6.9
Lee	7.6
Manatee	5.9
Monroe	6.0
Pasco	7.8
Pinellas	5.9
Sarasota	6.4
Southwest Florida	7.1
Florida	7.1

Table 12. The number of males and females employed in the counties of Southwest Florida in 1950, 1960, and 1970; percentage of State total (given in parenthesis) (U.S. Department of Commerce 1953, 1963, 1973).

	1950			1960			1970		
County	Male	Female	Total	Male	Female	Total	Male[a]	Female[a]	Total[a]
Charlotte	1,081	436	1,517	2,507	1,149	3,656	3,656	4,221	6,834
Collier	2,123	769	2,892	4,103	1,938	6,041	8,776	5,128	13,904
DeSoto	2,285	1,010	3,295	2,487	1,245	3,732	2,659	1,722	4,381
Hillsborough	62,562	28,832	91,394	92,532	48,036	140,568	111,242	70,109	181,351
Lee	6,095	2,772	8,867	12,877	6,396	19,273	22,109	13,870	35,979
Manatee	8,278	4,438	12,716	14,008	7,734	21,742	17,242	11,504	28,746
Monroe	4,763	1,711	6,474	7,964	4,360	12,324	8,841	6,024	14,865
Pasco	5,282	1,678	6,960	7,852	3,409	11,261	11,753	6,456	118,209
Pinellas	34,982	17,983	52,965	73,004	42,377	115,381	96,052	68,950	165,002
Sarasota	7,234	3,585	10,819	16,519	9,643	26,162	21,806	15,149	36,955
Southwest Florida	134,685 (13.3%)	63,214 (6.3%)	197,899 (19.6%)	233,853 (13.6%)	126,287 (7.3%)	360,140 (20.9%)	304,701 (12.6%)	210,525 (8.4%)	596,226 (21.0%)
Florida	693,093	316,522	1,009,615	1,118,681	600,910	1,719,591	260,669	146,319	2,404,988

[a]County tabulations subject to error.

number of babies born in the late 1980's (due to the large number of women of child bearing age) will be relatively high compared to the 1970's and will limit the availability of mothers in the labor force. Employment of women over 65 years is low and will likely remain that way in the 1980's. Despite these traditional employment impediments, the number and percentage of women in the labor force is sure to increase in the 1980's. Only one in twelve women over 65 is likely to be employed.

Since 1950, the number of men and women employed in Southwest Florida has consistently been about 20% of the State total and is expected to continue in the 1980's. The forecast is for an increasing number of men and women in the labor force largely due to the increase in population. Despite the increase in employment (number of jobs), the percentage of minority groups employed may remain low. The number of persons employed in Southwest Florida in 1971 to 1978 are given in Table 13.

LICENSED HEALTH PROFESSIONALS AND MEDICAL FACILITIES

Licensed health professionals and medical facilities are adequate in proportion to the population of Southwest Florida. For example, the region has approximately 24% of the State's population and 21% of all dentists, 20% of all the medical doctors, and 22% of all pharmacists (Table 14). In 1980, licensed health professionals in the region constituted 20% to 25% of all licensed professionals in the State. The number of hospitals and beds comprise 20% to 25% of the State's total (Table 15).

WHOLESALE AND RETAIL TRADE

Florida has the largest population and more retail sales than any other state in the Southeast and has held this position for 30 years. Nationally, in 1979, Florida was seventh with retail sales of $40.5 billion (Florida Chamber of Commerce 1979). Southwest Florida has about 20% of the State's wholesale establishments and wholesale sales (Table 16). It also has about 24% of the retail establishments and retail sales. The retail and wholesale trade sector is non-basic, i.e., it provides goods and services for local consumption.

SUMMARY AND CONCLUSIONS

The population in the Southwest coastal region of Florida is made up of a relatively high proportion of elderly persons. Much of their income is from outside the region, or from social security, pensions, and retirement funds. For this reason, and also due to limited employment opportunities, the labor force tends to be lower, considering the population, than the average for the State. Because of the high percentage of older people, high unemployment, and severe seasonal fluctuations in employment, the family and per capita income for Southwest Florida is slightly below that of the State.

Table 13. Number of employees in Southwest Florida, 1971 to 1978 (Florida Department of Commerce, Division of Economic Development 1979a - 1979g, 1980a - 1980b; Florida Statistical Abstract 1980).

County	1971	1972	1973	1974[a]	1975[a]	1976[a]	1977[a]	1978[a]
Charlotte	7,638	11,666	12,636	11,456	10,769	10,593	11,395	13,036
Collier	16,521	16,421	20,133	21,874	19,538	19,978	21,120	26,065
DeSoto	4,512	4,824	5,100	5,119	5,005	5,138	5,056	5,532
Hillsborough	383,985	405,378	458,226	246,994	238,748	233,629	235,728	254,274
Lee	38,684	40,171	49,115	53,156	51,293	53,872	56,882	64,246
Manatee	30,451	33,807	36,832	41,517	39,614	41,460	43,503	45,375
Pasco	14,014	15,865	16,176	17,075	16,458	17,368	17,529	18,271
Pinellas[b]				205,098	196,097	199,455	201,246	217,080
Sarasota	40,806	48,013	49,267	51,647	48,260	49,227	53,105	56,886
Southwest Florida	536,611	576,145	647,485	694,158	662,211	675,601	690,848	749,612
Florida	2,628,000	2,715,000	2,957,000	3,099,000	3,053,000	3,131,000	3,232,000	3,364,000

[a] County tabulations subject to error.
[b] Data for 1971-73 are included in Hillsborough County.

Table 14. The number of licensed health professionals for 1980 in Southwest Florida and their percent contribution (in parentheses) to the State total (Florida statistical abstract 1980).

County	Chiropractors	Dentists	Licensed practical nurses	Registered nurses[a]	Optometrists	Medical doctors
Charlotte	10	27	190	381	3	111
Collier	13	54	255	518	7	150
DeSoto	5	9	37	80	1	28
Hillsborough	84	295	2,114	3,366	54	1,173
Lee	33	98	604	1,314	16	292
Manatee	22	63	552	1,093	15	187
Monroe	8	31	92	373	8	99
Pasco	31	48	504	726	14	101
Pinellas	146	402	2,595	5,753	68	1,107
Sarasota	44	135	913	23	23	365
Southwest Florida	396 (29%)	1,162 (21%)	7,856 (28%)	15,307 (26%)	209 (24%)	3,613 (20%)
Florida	1,362	5,462	28,115	58,483	885	17,701

County	Osteopaths	Pharmacists	Podiatrists	Veterinarians
Charlotte	3	33	4	7
Collier	5	44	3	14
DeSoto	0	11	0	4
Hillsborough	51	344	20	79
Lee	13	124	9	30
Manatee	5	85	5	19
Monroe	1	32	1	14
Pasco	27	60	6	19
Pinellas	192	531	45	86
Sarasota	16	151	14	31
Southwest Florida	313 (33%)	1,415 (22%)	107 (24%)	303 (24%)
Florida	949	6,383	447	1,284

[a]County tabulations subject to error.

Table 15. The number of licensed general hospitals[a], number of beds, and number of beds per 1,000 population in Southwest Florida for FY 1977-78, FY 1978-79, and FY 1979-80 and their percentage contribution (in parentheses) to the State total (Florida statistical abstracts 1978, 1979, 1980).

County	FY 1977-78			FY 1978-79		
	Hospitals	Beds	Number of beds per 1,000 population	Hospitals	Beds	Number of beds per 1,000 population
Charlotte	3	463	10.45	3	463	9.22
Collier	1	253	3.67	1	313	4.20
DeSoto	1	69	3.84	1	69	3.75
Hillsborough	12	2,562	4.25	12	2,562	4.16
Lee	4	946	5.49	4	1,146	6.32
Manatee	2	810	6.26	2	810	5.98
Monroe	4	270	4.90	4	270	4.48
Pasco	4	510	3.58	4	510	3.40
Pinellas	16	4,338	6.31	17	4,584	6.47
Sarasota	3	1,012	5.93	3	1,078	5.88
Southwest Florida[b]	50 (23.3%)	11,233 (23.3%)	5.47	51 (17.2%)	11,805 (23.9%)	5.39
Florida	214	48,156	5.52	296	49,294	5.50

County	FY 1979-80		
	Hospitals	Beds	Number of beds per 1,000 population
Charlotte	3	622	11.23
Collier	1	313	3.82
DeSoto	1	69	3.61
Hillsborough	11	2,561	4.04
Lee	4	1,146	5.97
Manatee	2	810	5.74
Monroe	4	270	4.78
Pasco	4	510	3.15
Pinellas	17	4,578	6.31
Sarasota	3	1,131	5.88
Southwest Florida	50 (23.3%)	12,010	5.31
Florida	215	50,347	5.45

[a]Includes general hospitals without obstetrics.
[b]Percentages (in parentheses) represent portion of State totals in Southwest Florida.

Table 16. The number and sales volume of wholesale and retail sales in Southwest Florida in 1977 and their percent contribution (in parentheses) to the State total (Florida statistical abstract 1980).

County	Wholesale		Retail	
	Number of establishments	Sales ($1,000)	Number of establishments	Sales ($1,000,000)
Charlotte	34	12,402	438	151
Collier	104	132,672	965	343
DeSoto	23	22,697	141	40
Hillsborough	1,434	4,851,544	5,323	2,070
Lee	246	350,304	1,933	721
Manatee	128	203,508	1,108	477
Monroe	83	73,778	886	212
Pasco	95	152,176	1,089	342
Pinellas	779	972,417	5,810	2,438
Sarasota	240	203,014	2,055	776
Region	3,166 (20.5%)	6,974,512 (20.3%)	19,748 (24.0%)	7,570 (24.1%)
Florida	15,409	34,380,491	82,251	31,413

Net migration has caused most of the population increase in Southwest Florida in 1950-80. In general, the region is heavily populated (notably the Tampa-St. Petersburg metropolitan area), urban oriented, and fast growing.

Median school years completed by the people in Southwest Florida is about the same for the State. The median school years completed by non-Whites is much less than for the Whites, and the gap is widening. On the whole there seems to be adequate educational institutions, facilities, and programs to provide opportunities for continuing education, acquisition of entry-level job skill, upgrading, retraining, and literacy skill development.

The single greatest uptapped resource in Southwest Florida is the older age groups. The economic impact of residents 60 years old and older is of vital importance to the future development of cultural, health, government, natural and business environments, and has important public policy implications.

DATA GAPS AND INCONSISTENCIES

The single largest problem encountered in synthesizing demographic data pertaining to Southwest Florida was the lack of data from the 1980 census necessary to update population growth, trends, and distribution. This also

included specific data needed on labor force characteristics, unemployment, and income; therefore, the report is out-of-date in several areas (e.g., current number of employed persons per county, net migration of minorities, the percentage of families living at below the national poverty level of $9,290 in Southwest Florida).

No data were available from the Bureau of Census in 1950 to 1959 on non-Whites when there were fewer than 5,000 non-Whites in a particular county.

The analytical instrumentation necessary for indepth characterization of the economic forces affecting Southwest Florida are somewhat limited. Models calibrated with current data are needed to accurately reflect the flow of goods and services in Southwest Florida for both producers and consumers.

RECOMMENDATIONS

The problem of extrapolating census data and using it to reflect the characteristics of the population and the labor force can be solved, but only if more comprehensive and timely data are collected, compiled, and analyzed. Further development and testing of analytical tools, including the data appropriate for such analysis, is needed for detailed characterization of the economic forces affecting Southwest Florida. This sort of information (and a way to generate it) is crucial to the economic development of Southwest Florida.

The preponderance of elderly citizens in Southwest Florida should be reflected in the social, recreational, and economic planning by planners and policy-makers. Private and public sector policies and practices that discourage senior citizens from staying productively active and thereby accelerating processes that lead to dependency should be avoided.

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TRANSPORTATION

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INTRODUCTION

This report is a review of the transportation systems in Charlotte, Collier, DeSoto, Hillsborough, Lee, Manatee, Monroe, Pasco, Pinellas, and Sarasota Counties of Southwest Florida. The systems reviewed are seaports, airports, railroads, highways, bus transit, and pipelines.

Reasonably detailed information is available on all but railroad and pipeline systems. A synthesis of the findings on the modes of transportation is given in the following sections. Original data on length, area, weight, and other measurements are given in U.S. units of measure; conversion to metric system equivalents was not practiced. Short tons (2,000 lb) are used in this report and sometimes are referred to as volume.

SEAPORTS

PORT LOCATIONS

The location of the two major seaports in Southwest Florida (Tampa and Manatee) are shown in Figure 1. The harbors and shipping channels of the two ports exceed the depth requirements (27 ft) for most merchant ships and ocean barges (Florida Department of Transportation 1978a). Of the three medium seaports in the region (St. Petersburg, Boca Grande, and Key West), only St. Petersburg handles any appreciable amount of waterborne commerce. The small port at Tarpon Springs has neither the channel depth nor the facilities to engage in commercial cargo and serves primarily as a base for fishing and pleasure boating.

PORT CHARACTERISTICS

This section provides details concerning the physical characteristics and the past and projected cargo volume (tonnage) of the seaports. Specifics pertaining to the historical volumes of cargo are taken from the U.S. Army Corps of Engineers, Waterborne Commerce of the United States (1960, 1965, 1970, 1975, and 1980). Physical characteristics of the ports, and tonnage capaci-

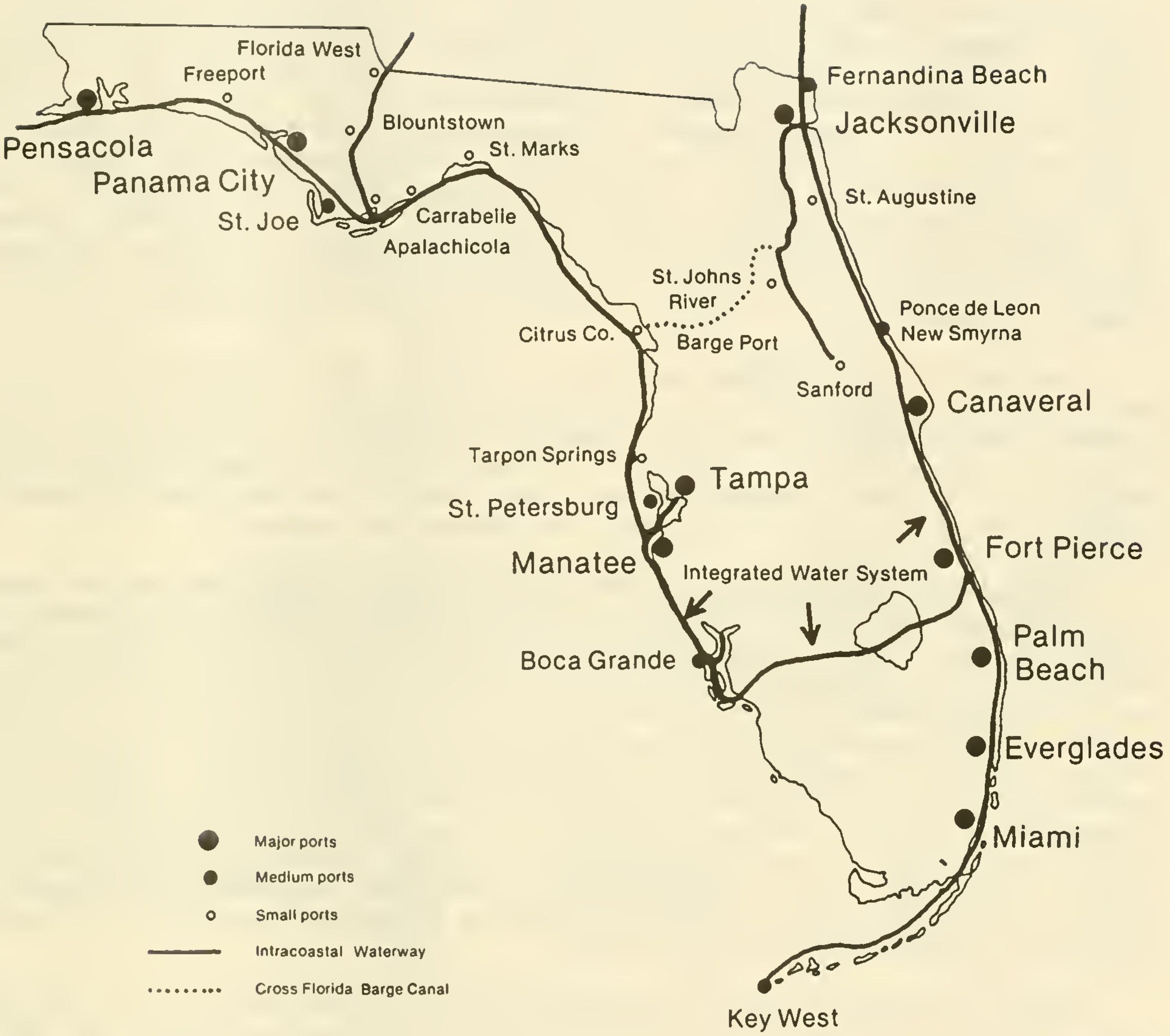

Figure 1. Location of ports and waterways in Florida (Florida Department of Transportation 1978b).

ties and projections are taken from the Florida Waterport Systems Study, Florida Department of Transportation (1978a).

Tampa

The Port of Tampa is located at the head of Hillsborough Bay (the easterly extension of Tampa Bay) in close proximity to Tampa's central business district. Deepwater access to the Gulf of Mexico is provided by 41 miles of dredged channel. Minimum channel dimensions are 34 ft deep and 400 ft wide. In 1978 the dredged main channel was deepened to 43 ft. Additional channels maintained at 30 ft depth connect the main port facilities on the Hooker's Point peninsula with various other terminals along the shores of Tampa, Old Tampa, and Hillsborough Bays. The main shipping channels also intersect the Port Manatee Channel, the St. Petersburg Channel, and the Intracoastal Waterway. Other means of access to the port are the Seaboard Coast Line Railroad, Interstate Highways (I-4 and I-75), Tampa International Airport, and the Peter O. Knight Municipal Airport, which maintains a seaplane landing basin.

The port's cargo storage capacity in 1975 was about 843,738 ft^2 of covered storage, 1,750,000 ft^2 of refrigerated storage, 4,095,511 ft^2 of open storage, and 10,843,145 barrels of liquid bulk storage. Ship berthing facilities consist of 21,178 linear ft of port authority owned wharves and 34,522 ft of privately owned wharves. Most berths are maintained at depths exceeding 30 ft. A total of 82 docks are located in the port.

Estimates of the throughput cargo handling capacity for the Port of Tampa were developed for the Florida Waterport Systems Study (Florida Department of Transportation 1978a). These estimates were based on port labor and equipment productivity relationships (provided by the U.S. Department of Commerce, Federal Maritime Administration), an assumed 40-hr work week, and an annual sustained berth occupancy of 50%. These capacity estimates tend to be conservative and do not represent their maximum physical capacities. Estimates are made on break bulk, dry bulk, liquid bulk, and general cargo categories of shipments. Break bulk refers to cargo in a vessel that can be counted by unit (e.g., tractors); dry bulk and liquid bulk refer to bulk cargo carried in specially designed ships; and general cargo refers to any commodity shipped in boxes, crates, or other packaging. Estimated throughput capacities for Tampa in 1975 are shown in Table 1.

Tampa's freight tonnage increased sharply in 1960-78 and it is now the largest port on the west coast of Florida, if not for the State. In 1975, Tampa's volume of waterborne commerce was 39,857,660 tons, about 49% of the State total. A summary of the changes in annual port tonnage in 1960-78 is shown in Table 2. Although the port has maintained a diversified mix of general cargo, the largest percentage has been bulk cargo. In 1978, phosphate was by far the greatest export (11.4 million tons), and petroleum products were the primary imports (6.6 million tons). Because of the emphasis on bulk cargo, conveyor belts and pipelines are the most important means of transport.

Forecasts of general cargo, phosphate exports, and petroleum product imports for the Port of Tampa were made by the Florida Waterport Systems Study (Florida Department of Transportation 1978a). In general, these forecasts are based upon the port's share of Florida waterborne commerce, annual growth rates of cargo volumes in Florida and the United States, world economic

Table 1. Annual throughput capacity (in tons) for the Port of Tampa in 1975 (Florida Department of Transportation 1978a).

Cargo	Capacity
General cargo	1,612,000
Dry bulk	
Phosphate	34,300,000
Other	8,010,000
Liquid bulk	
Oil	12,740,000
Other	2,626,000

Table 2. Port of Tampa annual freight tonnage for intermittent years 1960-78 (Florida Department of Transportation 1978a).

Year	Tons	Percentage increase
1960	14,786,470	--
1965	19,829,071	34
1970	31,356,522	112
1975	39,857,660	169
1978	47,077,047	218

trends, and assessments of competition between Florida and other U.S. ports. The annual general cargo forecasts for Tampa are given in Table 3.

A general cargo growth of 44.9% is expected in the Port of Tampa between 1980 and 2000. The forecasts for annual export of phosphate rock and import of bulk petroleum products are shown in Table 4. Petroleum product imports are expected to increase in 1980-2000 and phosphate rock exports are expected to increase until 1990 and decrease thereafter. The decline probably will result from the depletion of known reserves in Florida and the need to conserve supplies for domestic fertilizers.

Table 3. Forecast of export, import, and throughput general cargo (in tons) for the Port of Tampa in 1980, 1985, 1990, and 2000 (adapted from Florida Department of Transportation 1978a).

Cargo	1980	1985	1990	2000
Foreign				
Imports	827,000	914,000	977,000	1,111,000
Exports	1,652,000	1,948,000	2,167,000	2,584,000
Domestic				
Imports	106,000	115,000	123,000	137,000
Exports	212,000	215,000	218,000	222,000
Total throughput	2,797,000	3,192,000	3,485,000	4,054,000

Table 4. Forecast of phosphate exports (in tons) and petroleum imports (in tons) for the Port of Tampa at 5-year intervals, 1980-2000 (adapted from Florida Department of Transportation 1978a).

Year	Phosphate	Petroleum
1980	22,400,000	11,571,000
1985	24,300,000	12,844,000
1990	25,600,000	14,257,000
1995	24,900,000	15,255,000
2000	23,800,000	16,383,000

Manatee

The Port of Manatee is located on a 675-acre site on the south side of the entrance to Tampa Bay in Manatee County. Manatee is approximately 25 miles down channel from the Port of Tampa and is connected to the Tampa Bay Channel by the Port Manatee Channel, which is 3 miles long and maintained at a width of 400 ft and a depth of 38 ft. Other water access to the port is provided by the Saint Petersburg Channel and the Florida Intracoastal Waterway. Other transport linkages are provided by a port-owned and operated railroad connecting the Seaboard Coast Line Railroad, by a petroleum pipeline which supplies the Florida Power and Light Company, and by the Tampa International Airport, and by local highways. The principal highway routes are U.S. 41 and I-75.

The Port of Manatee's storage facilities in 1975 were 326,000 ft^2 of covered storage and a bulk petroleum storage capacity of 3,800,000 barrels (bbl). Ship berthing facilities included two shallow berths 20 ft deep, and five deep berths ranging from 37 ft to 40 ft deep.

The Port of Manatee is used mainly for bulk cargo. Almost 90% of the port's business is petroleum and petroleum products. Estimates of the throughput capacity of the Port of Manatee in 1975 are given in Table 5.

Port Manatee began cargo service in 1970 and in 1980 petroleum, phosphate, fertilizer, feed, cement, scrap steel, plywood, pipe, and offshore drilling materials generated 5 million tons of commerce. Of this total, 3 million tons were petroleum receipts and 1.5 million tons were fertilizer/phosphate shipments. No forecasts were made for this port by the Florida Waterport Systems Study (Florida Department of Transportation 1978a). Based on analysis of tributary area demands, the Manatee County Port Authority has estimated that its commerce should reach 8 million tons by 1985.

St. Petersburg

The Port of St. Petersburg is located on the west shore of Tampa Bay, adjacent to the downtown area of the city of St. Petersburg. Access to the port is provided by a 1.7-mile channel, maintained at a 16-ft water depth which connects to the Tampa Bay Channel. Other means of access are provided

Table 5. Throughput capacity (in tons) for the Port of Manatee in 1975 (Florida Department of Transportation 1978a).

Category	Capacity
General cargo	
Ship/apron transfer	328,000
Storage/truck transfer	333,000
Covered storage	355,000
Liquid bulk (fuel oil)	
Ship/apron transfer	11,701,000
Tank storage	9,080,000
Storage, truck transfer	6,749,000
Dry bulk (fertilizer)	
Ship/apron transfer	671,000
Storage capacity	786,000
Storage/rail transfer	516,000

by the port's proximity to three airports (Whitted, Tampa International, and St. Petersburg-Clearwater International), Interstate 275 and U.S. 19, and the Intracoastal Waterway approximately 5 miles south of the port. No direct rail service is available.

The port's berth facility is comprised of a 900-ft by 1,800-ft slip with docking space along 3,900 ft of bulkhead. The Albert Whitted Airport, a part of the port complex, is available for air freight. Just west of the port, another small port named Bayboro Harbor is privately operated. It has a commercial fishing wharf and power plant facilities that include provisions for receiving fuel by barge.

In 1978, the Port of St. Petersburg's volume of cargo was only 234,000 tons. This port is used primarily as a base for small craft (fishing and pleasure) and for passenger cruises.

Boca Grande

Boca Grande is located on the south end of Gasparilla Island near the entrance to Charlotte Harbor. The port is connected to the Gulf of Mexico by a 32-ft deep channel. Once active in both phosphate and petroleum shipments, Boca Grande has not served as a public port since 1978. Attempts to create a new facility nearby have not materialized.

Key West

The Port of Key West is located in the northwest corner of the island of Key West. It is located approximately 220 mi south of the entrance to Tampa Bay. Key West is mainly used as a port of safe haven. No commodities are transported except for local use.

Tarpon Springs

The Tarpon Springs docks are located on the Anclote River about 2 miles from the Gulf of Mexico in downtown Tarpon Springs. The channel/harbor depth is only 9 ft. This port does not serve waterborne commerce. Principal uses of the port are for recreational craft and sponge fishing boats.

AIR TRANSPORTATION

DESCRIPTION OF AIRPORTS

Southwest Florida has 3 commercial and 24 smaller public airports. The public airport facilities in 1980 are listed by type and county in Table 6. Inventories of facilities in the following sections were taken from Florida Airports (Florida Department of Transportation 1981). The history and projections of annual air carrier passenger enplanements for commercial airports are given in the next section on airport activity. The number of enplanements represents the number of departing passengers. The number of aircraft operations, as used in this text, represents the number of landings and take-offs.

Table 6. Type of public airports, number of runways, locally based airplanes, and aircraft operations in Southwest Florida in 1980 (Florida Department of Transportation 1981).

Name of airport	Number of runways	Longest runway (feet)	Number of based airplanes	Number of annual operations
Charlotte County	3	5,000	94	44,445
Rotonda	1	4,200	9	12,000
Everglades	1	2,400	4	4,000
Immokalee	3	5,000	27	23,000
Marco Island	1	5,008	11	14,000
Naples Municipal	2	5,000	131	100,347
Arcadia Municipal	2	2,678	40	18,000
Brandon	1	2,775	64	32,000
Hillsborough	1	2,500	30	19,000
Peter O'Knight	2	3,400	103	56,000
Plant City Municipal	1	3,050	38	46,000
Tampa International	3	11,000	105	240,000
Vandenberg	1	3,260	208	70,000
Page	2	6,401	167	141,096
Key West International	1	4,800	45	60,355
Marathon Flight Strip	1	5,000	56	41,000
Port Largo	1	2,295	10	5,000
North Tampa	1	3,540	27	21,000
Pilot	1	3,700	10	4,000
West Pasco	1	5,000	77	45,000
Zephyrhills	3	5,550	28	13,000
Albert Whitted	2	3,322	155	102,000
St. Petersburg/Clearwater	3	7,989	230	277,680
Buchan	2	2,750	15	7,000
Sarasota/Bradenton	2	7,000	196	155,934
Venice Municipal	2	5,000	155	97,000

Charlotte County Airport

This airport is located 3 miles southeast of Punta Gorda in Charlotte County. In 1980, the airport had three paved runways of 5,000 ft each and served nine daily airline flights. The number of aircraft based there was 94 and the number of aircraft operations (number of takeoffs and landings) was 44,445.

Rotonda Airport

The Rotonda Airport is 1 mile south of Rotonda on State Road 771 in Charlotte County. In 1980, the single paved runway was 4,200 ft long and served 12,000 aircraft operations. Nine aircraft were based at the field.

Everglades Airport

This small airport is 1 mile southwest of Everglades City in Collier County. The single paved runway was 2,400 ft long and served 4,000 aircraft operations in 1980. Four aircraft were based at the field.

Immokalee Airport

The Immokalee Airport is 1 mile northeast of Immokalee in Collier County. In 1980, the airport had three paved runways of 5,000 ft each, 27 based aircraft, and served 23,000 aircraft operations.

Marco Island Airport

This airport is 6 miles northeast of Marco in Collier County. In 1980, the single paved runway was 5,008 ft long and served 14,000 aircraft operations. Eleven aircraft were based at the field and six daily airline flights were scheduled.

Naples Municipal Airport

This airport is 2 miles northeast of Naples in Collier County. In 1980, there were two paved runways of 5,000 ft and 100,347 aircraft operations. A total of 131 aircraft were based at the field and 10 daily airline flights were scheduled.

Arcadia Municipal Airport

This airport is located 2 miles southeast of Arcadia in DeSoto County. In 1980, there were two unpaved runways, one 2,678 ft long and one 2,300 ft long, 40 based aircraft, and 18,000 aircraft operations.

Brandon Airport

The Brandon Airport is located 3 miles south of Brandon in Hillsborough County. In 1980, the field had a single unpaved runway of 2,775 ft, 64 based aircraft, and 32,000 aircraft operations.

Hillsborough Airport

This airport is located 9 miles east of Tampa in Hillsborough County. In 1980, the field had a single unpaved runway of 2,500 ft, 30 based aircraft, and 19,000 aircraft operations.

Peter O. Knight Airport

This airport is 4 miles south of Tampa in Hillsborough County. The field is adjacent to the Port of Tampa in Hillsborough Bay and maintains a seaplane landing basin. In 1980, the field had two paved runways 3,400 ft and 2,700 ft long, 103 based aircraft, and 56,000 aircraft operations.

Plant City Municipal Airport

This airport is 2 miles southwest of Plant City in Hillsborough County. In 1980, the field had a single paved runway of 3,050 ft, 38 based aircraft, and 46,000 aircraft operations.

Tampa International Airport

Tampa International is the largest airport in Southwest Florida and is 5 miles west of downtown Tampa in Hillsborough County. In 1980, the field had three paved runways. Their lengths were 11,000 ft, 8,300 ft, and 7,000 ft. In 1980, the airport served 230 daily airline flights, 105 based aircraft, and 240,000 aircraft operations.

Vandenberg

The Vandenberg Airport is 7 miles east of Tampa in Hillsborough County. In 1980, the field had a single paved runway of 3,260 ft, 208 based aircraft, and 70,000 aircraft operations.

Lee County-Page Field

This airport is 4 miles south of Fort Myers in Lee County. In 1980, the field had two paved runways of 6,401 ft and 5,000 ft, 72 daily airline flights, 167 based aircraft, and 141,096 aircraft operations.

Key West International

Key West International is 2 miles east of Key West in Monroe County. In 1980, the field had a single paved runway of 4,800 ft, 10 daily airline flights, 45 based aircraft, and 60,355 aircraft operations.

Marathon Flight Strip

The Marathon Flight Strip is located 2 miles east of Marathon in Monroe County. In 1980, the field had a single paved runway of 5,000 ft, four daily airline flights, 56 based aircraft, and 41,000 aircraft operations.

Port Largo

This airport is 1 mile east of Key Largo in Monroe County. In 1980, the field had a single paved runway of 2,295 ft, 10 based aircraft, and 5,000 aircraft operations.

North Tampa

The North Tampa Airport is 17 miles northeast of Tampa in Pasco County. In 1980, the field had a single paved runway of 3,540 ft, 27 based aircraft, and 21,000 aircraft operations.

Pilot County

The Pilot County Airport is 15 miles southwest of Brooksville in Pasco County. In 1980, the field had a single paved runway of 2,700 ft, 10 based aircraft, and 4,000 aircraft operations.

West Pasco

This airport is 7 miles southeast of New Port Richey in Pasco County. In 1980, the field had a single paved runway of 5,000 ft, 77 based aircraft, and 45,000 aircraft operations.

Zephyrhills Municipal

This airport is 1 mile southeast of Zephyrhills in Pasco County. In 1980, the field had three paved runways of 5,000 ft, 5,200 ft, and 5,550 ft, 28 based aircraft, and 13,000 aircraft operations.

Albert Whitted Municipal

The Albert Whitted Municipal Airport is part of the St. Petersburg Seaport complex in Pinellas County and features a seaplane landing basin and ramp. In 1980, the field had two paved runways of 2,800 ft and 3,322 ft long, 155 based aircraft, and 102,000 aircraft operations.

Clearwater Executive

Clearwater Executive Airport is located within the City of Clearwater in Pinellas County. In 1980, this field had a single paved runway of 3,000 ft, 150 based aircraft, and 70,000 aircraft operations.

St. Petersburg-Clearwater

This airport is located within the City of St. Petersburg in Pinellas County. In 1980, the field had three paved runways of 7,989 ft, 5,165 ft, and 5,722 ft, 230 based aircraft, and 277,680 aircraft operations.

Buchan

Buchan Airport is 2 miles north of Englewood in Sarasota County. In 1980, the field had two unpaved runways of 2,750 ft and 2,240 ft, 15 based aircraft, and 7,000 aircraft operations.

Sarasota-Bradenton

This airport is 3 miles north of Sarasota in Sarasota County. In 1980, the field had two paved runways of 5,006 ft and 7,000 ft, 40 daily airline flights, 196 based aircraft, and 155,934 aircraft operations.

Venice Municipal

Venice Municipal Airport is 0.5 mile south of Venice in Sarasota County. In 1980, the field had two paved runways of 5,000 ft, 155 based aircraft, and 97,000 aircraft operations.

AIRPORT OPERATIONS

Commercial Airports

To establish the level of operations among the airports within the 10 county region, standard FAA workload measures were employed. The basic measure for commercial airports is the number of enplaning passengers (persons boarding commercial flights) per year. Past and projected volumes of passenger enplanements for the three commercial airports are given in Table 7.

Commercial airline forecasts, given in this section, were made for the Florida Department of Transportation (1975) as part of the Florida Aviation System Plan. The forecasting employed were (1) correlation analysis (population history with enplanement history); (2) share of the market (regional enplanement history with U.S. enplanement history; and (3) linear ft (regional enplanements with regional population history). The variables used were population, payroll, and tourist accommodations. These forecasts predict that Tampa will remain the dominant airport in the region, but the Lee County-Page Field Airport will grow the fastest in 1980-90.

General Aviation Airports

The basic operations measure for general aviation facilities is the number of takeoffs and landings (aircraft operations) per year. Historical and predicted annual aircraft operations for these airports in Southwest Florida are shown in Table 8. Future operation levels are taken from Federal Aviation Administration (FAA) Aviation Forecasts (U.S. Department of Transportation 1979). The procedure used was to apply the FAA forecasted growth percentage (42%) for general aviation aircraft operations from 1979 to 1991 for Southwest Florida as a whole, and then allocate this growth based on each airport's market share of the operations reported in 1980.

Table 7. Number of past (1970 and 1979) and projected (1980, 1985, and 1990) air carrier enplanements[a] for three major airports in Southwest Florida (Florida Department of Transportation 1975).

Airport	1970	1974	1980	1985	1990
Tampa International	1,520,400	2,424,300	3,972,900	5,586,600	8,013,000
Lee County-Page Field	--	147,400	350,500	631,600	992,200
Sarasota-Bradenton	146,400	275,400	434,600	784,500	1,155,100

[a]Number of passengers boarding commercial flights.

Table 8. Number of aircraft operations in 1972 and 1980 and projections to 1991 among general aviation airports in Southwest Florida (Florida Department of Transportation 1975, 1981).

Airport	Annual aircraft operations 1972	1980	1991
Charlotte County	35,000	44,445	63,100
Rotonda	--	12,000	17,000
Everglades	1,400	4,000	5,700
Immokalee	20,000	23,000	32,700
Marco Island	--	14,000	20,000
Naples Municipal	6,000	100,347	142,500
Arcadia Municipal	7,000	18,000	25,600
Brandon	25,000	32,000	45,400
Hillsborough	7,500	19,000	27,000
Peter O'Knight	60,650	56,000	79,500
Plant City Municipal	30,300	46,000	65,300
Vandenberg	97,000	70,000	99,400
Key West International	62,528	60,355	85,700
Marathon Flight Strip	17,798	41,000	58,200
Port Largo	3,000	5,000	7,100
North Tampa	10,700	21,000	29,800
Pilot	--	4,000	5,700
West Pasco	6,000	45,000	63,900
Zephyrhills	8,000	13,000	18,500
Albert Whitted	100,280	102,000	144,800
Clearwater Executive	55,500	70,000	99,400
St. Petersburg-Clearwater	208,449	277,680	394,300
Buchan	1,000	7,000	9,900
Venice Municipal	50,550	97,000	137,700

RAIL TRANSPORTATION

The Seaboard Coast Line Railroad (SCL) provides the only rail freight service in Southwest Florida. This Class I railroad (net annual operating revenue of $10,000,000 or more) is part of the Family Lines System and is headquartered in Jacksonville (Figure 2). The Family Lines System operates 3,100 route miles in Florida and connects with all other lines operating in the State. The Florida State rail plan (Florida Department of Transportation 1978b) lists 1,337 locomotives and 63,758 freight cars for SCL. Trailer-on - flatcar or piggyback loading facilities are maintained by the SCL at Tampa, Bradenton, Arcadia, Fort Myers, and Immokalee.

Tampa and the nearby phosphate producing areas are a major source of traffic for the SCL. In 1976, the Tampa yards routed about 1,600 cars daily over 63 tracks. In 1975, the operating revenue of SCL was $153,596 and the operating expense was $142,021.

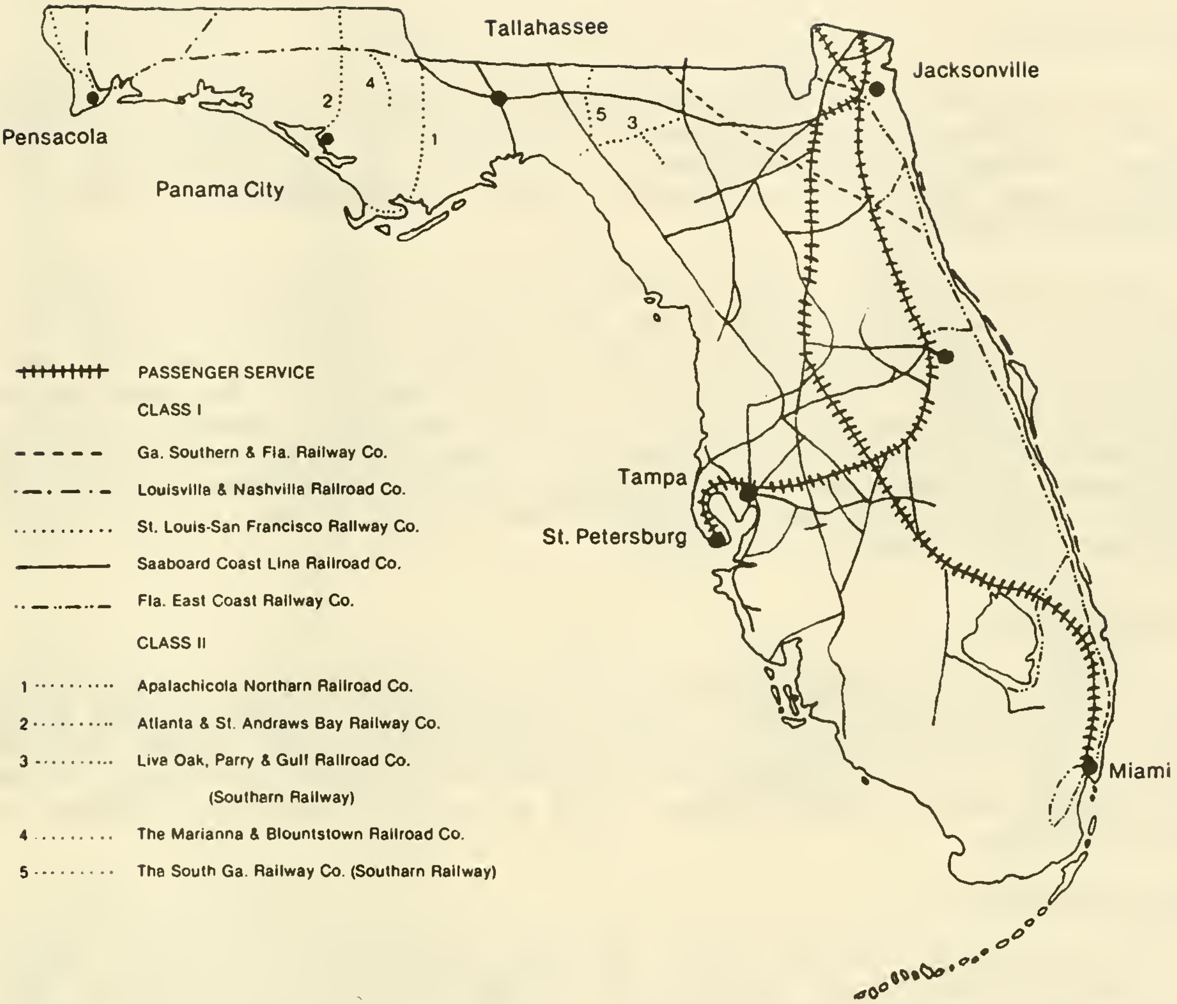

Figure 2. Passenger and freight railroads in Florida (Florida Department of Transportation 1978a).

Few details are available for analysis of railroad operations in Southwest Florida and no projections have been made for the future. The status of passenger transportation service due to AMTRAK service abandonments is uncertain.

HIGHWAY TRANSPORTATION

MAJOR NETWORKS

The locations of existing and committed interstate highways in Florida are shown in Figure 3. In Southwest Florida, I-75 is the major north-south highway. Because of the convergence of I-75 with I-4 near Tampa and St. Petersburg, these two cities are better served by highways than any other part in Southwest Florida.

Interstate Route 75 connects Tampa and St. Petersburg with Bradenton, Sarasota, Port Charlotte, Fort Myers, and Naples. At Naples, the four lane I-75 connects with the Everglades Parkway (Alligator Alley), a two lane roadway providing direct east-west access to Fort Lauderdale. The other major north-south highway serving the region is US-41, which also connects the major west coast cities listed above. South of Tampa, the major traffic flow is north-south; the east-west roadway network is relatively sparse and lightly traveled. More detailed descriptions of the highway systems in each county are given in the following subsections.

Charlotte County

The major north-south highways serving Charlotte County are I-75, US-41, US-17, and State Route-31 (SR). US-17 connects Port Charlotte/Punta Gorda with Arcadia, Lakeland, and Interstate Route 4 to the north. State Route 31 provides the most direct north-south connection between Fort Myers in Lee County and Arcadia in DeSoto County. There are no major east-west highways in Charlotte County.

Collier County

In addition to I-75 and US-41, the north-south travel in Collier County is served by SR-29, which connects US-41 near the Everglades National Park with Immokalee and US-27 to the north. Two major east-west routes serving Collier County are Everglades Parkway (Alligator Alley) and US-41, which converge near Naples.

DeSoto County

DeSoto County's major north-south arteries are US-17 and SR-31. The major east-west arteries are SR-70, which connects Arcadia with Bradenton, and SR-72, which connects Arcadia with Sarasota.

Hillsborough County

Major north-south arteries in Hillsborough County are I-75, US-41, US-301, and SR-39. The east-west arteries are I-275, US-92, and SR-60, which

Figure 3. Major Florida highways (Florida Department of Transportation 1978b).

connect Tampa and St. Petersburg, and I-4, which connects Tampa with Orlando.

Lee County

The major north-south arteries in Lee County are I-75, US-41, and SR-31. Major east-west arteries are SR-78, SR-80, and SR-82. SR-80 connects Fort Myers with Clewiston and US-27 on the south side of Lake Okeechobee. SR-82 connects Fort Myers with Immokalee in Collier County. SR-78 is a recreational route connecting Fort Myers with the Gulf of Mexico and Pine Island.

Manatee County

Manatee County is connected to the Tampa/St. Petersburg area by US-19 via the Sunshine Skyway, US-41 and US-301. Until the Tampa bypass of I-75 is completed in 1985, there will be a gap in the freeway system between Bradenton and Tampa. The east-west highways in the county are lightly traveled and consist of three two-lane roads, SR-62, SR-64, and SR-70.

Monroe County

Monroe County, consisting mostly of Everglades Wetlands, is served by only one highway. The route, US-1, connects Key West with Miami. Because of its wetland topography and geographic location, Monroe County is the most inaccessible county in Southwest Florida.

Pasco County

The major north-south roads in Pasco County are I-75, US-19, US-41, and US-301. The two major east-west roadways are SR-52 and SR-54. These roads connect US-19, which is on the heavily populated western side of the county, with I-75 to the east.

Pinellas County

Pinellas County, located on a peninsula between Tampa Bay and the Gulf of Mexico, is served largely by US-19, which runs north and south and is heavily congested, and the following major east-west highways: I-275, US-92, SR-60, SR-580, and SR-584. These east-west highways provide direct access to Tampa and Hillsborough County highways.

Sarasota County

Sarasota County is served by I-75 and US-41 for north-south travel. The only significant east-west highway, SR-72, connects the City of Sarasota with Arcadia in DeSoto County.

HIGHWAY CHARACTERISTICS

Highways usually are described by their width (travel surface), number of lanes, direction, average daily traffic volume, and capacity at level of service C. These data are difficult to interpret because of changes of traffic along a given route caused by localized variations in travel demand and inter-

secting traffic flows. A general picture of highway conditions in Southwest Florida is given in Table 9. The roadway widths generally represent the minimum widths, which are most often encountered outside of the city limits in rural areas. These narrow roadways determine the capacity for inter-county travel.

To indicate the relative use of the highways in each county, a traffic volume range was produced. The low volumes generally correspond to the average daily traffic reported by the Florida Department of Transportation on the narrow rural sections of roadway described above. The high volumes are encountered in towns or at major intersections. In these cases, the widths are generally greater than those shown in the table.

Capacity (volume of traffic) computations were based upon procedures documented in the Highway Capacity Manual (Florida Department of Transportation 1965). For capacity level C, 10% of the traffic is trucks, the terrain is level, peak hour traffic equals 12% of the average daily traffic, and the directional split is 60/40.

US-41 is the most congested roadway in Southwest Florida (Table 9). With the opening of I-75 from Bradenton and Naples in 1982, much of the traffic will be diverted from US-41. In Pasco County, for example, US-41 traffic is considerably lower because I-75 absorbs much of the I-75 north-south traffic. The next most congested highways in the region are US-19, I-75, and SR-60, all in the Pinellas County area.

Historical changes in traffic volumes at designated locations in the State are documented by a permanent traffic recording stations maintained by the Florida Department of Transportation. The average daily traffic volumes reported at the temporary recording stations in Southwest Florida are in Table 10.

TRAFFIC VOLUME FORECASTS

The Florida Department of Transportation has studied traffic volume changes in each of the 10 counties since 1929. These observed changes were correlated with county population and motor vehicle registrations. From these data, projections were made for traffic in each county (Table 10). The projections were made by multiplying a base year traffic volume by a 20-year growth factor. For example, to estimate the 1997 traffic in Charlotte County, the 1977 traffic volumes were multiplied by 3.652 (the 20-year growth factor).

The usefulness of these estimates is restricted, however, to roads located outside of areas having an ongoing Urbanized Area Transportation Study (UATS). In Southwest Florida, there are UATS for Tampa, St. Petersburg, Sarasota, Bradenton, and Fort Myers. Newly emerging UATS areas are in Pasco County (Port Richey) and Collier County (Naples). Documentation of UATS data collection, modeling, and network assignment procedures and forecasted traffic volumes are maintained by the Florida Department of Transportation, Division of Planning.

Table 9. The highways in the counties of Southwest Florida and some of their traffic characteristics in 1965 and 1977 (Florida Department of Transportation, Division of Transportation Planning, unpublished traffic volumes).

County	Road	Direction	Minimum width in feet	Average daily traffic volume 1965	Average daily traffic volume 1977	Capacity level C
Charlotte	SR-31	NS	20	500 to 700	900 to 3,200	8,100
	US-17	NS	22	1,200 to 3,000	2,800 to 7,100	8,800
	US-41	NS	48	5,900 to 12,000	11,000 to 31,500	29,200
Collier	SR-29	NS	20	500 to 2,300	800 to 3,400	8,100
	SR-82	EW	20	1,600	2,800	8,100
	SR-84	EW	24	--- ---	2,100 to 3,600	9,400
	US-41	NS	24	1,800 to 8,500	1,800 to 25,200	9,400
DeSoto	SR-31	NS	24	1,500 to 1,600	900 to 3,200	9,400
	SR-70	EW	24	600 to 2,900	2,300 to 9,700	9,400
	SR-72	EW	18	1,000 to 1,300	1,300 to 1,300	7,100
	US-17	NS	22	1,400 to 5,200	2,800 to 7,100	8,800
Hillsborough	SR-39	NS	22	2,900 to 6,100	3,600 to 10,200	8,800
	SR-60	EW	40	8,400 to 17,100	13,600 to 38,800	26,700
	US-41	NS	24	5,600 to 15,200	12,300 to 21,700	9,400
	US-92	EW	40	3,800 to 17,200	7,700 to 22,500	26,700
	US-301	NS	22	3,500 to 10,700	4,100 to 15,000	8,800
	I-4	EW	48	13,000 to 18,200	22,700 to 40,200	29,200
	I-275	EW	48	19,800 to 19,800	31,300 to 31,300	29,200
Lee	SR-31	NS	20	700 to 1,400	3,200 to 5,900	8,100
	SR-78	EW	20	1,700 to 3,500	3,000 to 5,000	8,100
	SR-80	EW	24	2,500 to 12,600	3,700 to 17,100	9,400
	SR-82	EW	20	1,000 to 3,700	2,800 to 10,100	8,100
	US-41	NS	48	5,200 to 11,700	9,200 to 21,900	29,200

(continued)

Table 9. (Concluded).

County	Road	Direction	Minimum width in feet	Average daily traffic volume 1965	Average daily traffic volume 1977	Capacity level C
Manatee	SR-62	EW	20	300	1,600 to 2,600	8,100
	SR-64	EW	24	600 to 12,200	1,100 to 14,900	9,400
	SR-70	EW	20	600 to 2,000	2,700 to 3,900	8,100
	US-19	NS	48	5,600 to 6,000	17,500 to 17,500	29,200
	US-41	NS	20	4,500 to 10,300	11,300 to 34,400	8,100
	US-301	NS	24	3,500 to 4,400	6,500 to 11,700	9,400
Monroe	US-1	NS	20	2,600 to 17,000	6,400 to 13,000	8,800
Pasco	SR-39	NS	22	2,000	5,800	8,100
	SR-52	EW	20	500 to 2,700	4,600 to 15,700	8,100
	SR-54	EW	24	400 to 2,600	6,800	9,400
	US-19	NS	48	4,600 to 14,500	6,700 to 46,200	29,200
	US-41	NS	24	4,400 to 7,000	6,700 to 7,900	9,400
	US-301	NS	22	5,100 to 12,900	11,900 to 20,800	8,800
	I-75	NS	48	--- ---	15,100 to 19,200	29,200
Pinellas	SR-60	EW	40	9,100 to 9,100	28,200 to 48,800	26,700
	SR-580	EW	24	3,000 to 8,400	6,500 to 18,000	9,400
	SR-584	EW	24	1,500 to 3,100	8,000 to 8,000	9,400
	US-19	NS	48	10,400 to 23,000	17,500 to 51,800	29,200
	US-92	EW	40	13,300 to 13,300	14,200 to 20,000	26,700
	I-275	EW	48	20,700	54,300	29,200
Sarasota	SR-72	EW	20	--- ---	400 to 8,200	8,100
	US-41	NS	48	17,400 to 24,200	23,400 to 34,300	29,200

Table 10. Average daily traffic at Florida Department of Transportation permanent traffic recording station in Southwest Florida in 1965 to 1980 (1975-80 percentage change in parenthesis) (Florida Department of Transportation, Division of Transportation Planning 1981).

Station	Location	County	1965	1970	1975	1980
13	US-41 at SR-597	Pasco	7,045	8,515	14,610	17,400 (19)
14	US-41, 4 mi S of Punta Gorda	Charlotte	4,920	6,655	7,940	10,910 (37)
39	SR-80 at County Line	Lee	1,930	2,455	2,850	4,585 (61)
68	SR-70, 6 mi NW of Arcadia	DeSoto	635	1,490	2,185	3,135 (44)
79	US-98 - US-301, 5 mi N of Dade City	Pasco	7,430	6,030	9,420	10,415 (11)
80	US-92, 2 mi W of Plant City	Hillsborough	3,750	5,015	6,120	6,695 (9)
86	US-92, W side of Gandy Bridge	Pinellas	8,955	10,795	12,071	13,797 (14)
94	US-41, S of SR-84 in Naples	Collier	3,840	8,795	18,235	22,927 (26)
106	I-4, 4 mi N of Plant City	Hillsborough	13,020	18,765	25,665	31,923 (24)
110	I-275, E side of Frankland Bridge	Hillsborough	19,400	32,055	40,470	48,165 (19)
123	I-75, 0.6 mi of I-4	Hillsborough	--	58,025	--	92,000 (--)
143	SR-29 at Immokalee	Collier	--	--	3,955	4,763 (20)
145	US-17, 1 mi N of Arcadia	DeSoto	--	--	4,385	5,270 (20)
146	SR-64, 15 mi N of Bradenton	Manatee	--	--	2,450	2,050 (-16)
147	SR-60 at SR-39	Hillsborough	--	--	10,070	11,244 (12)
148	US-19 at SR-688	Pinellas	--	--	22,130	23,520 (6)
155	US-1 at Lower Matecombe Key	Monroe	--	--	--	6,400 (--)

BUS SYSTEMS

Southwest Florida is currently served by Greyhound and Trailways intercity bus routes. No information on the intercity lines was found other than fares and schedules readily available anywhere.

Local (bus) transit services operate in Hillsborough, Lee, Manatee, Monroe, Pinellas, and Sarasota Counties. Transit service and inventory summaries for each of these counties is given in the following subsections. These data pertain to the 1980-81 fiscal year.

Hillsborough County

The Hillsborough Transit Authority operated 82 motor buses and carried 5,800,122 passengers. Service was provided 7 days a week on 449 mi of bus routes. There were 3,235,400 revenue miles of service and 235,060 vehicle hours of operation. The base fare for Hillsborough Transit was $0.50; the elderly, handicapped, and students could travel for one-half the base fare.

Lee County

The Lee County Transit System operated 18 motor buses and carried 851,600 passengers. Six smaller buses were used to provide demand responsive (taxi) service for an additional 51,200 passengers. Service was provided 6 days a week (no Sundays) on 256 miles of bus routes. There were 728,000 revenue vehicle miles of service and 47,720 vehicle hours of operation for the motor bus (fixed route) fleet. Corresponding figures for the demand responsive service were 166,400 and 12,288, respectively. The base fare for fixed route service was $0.50; the elderly and handicapped were charged half fare. Demand response fares varied between $1.00 and $3.00 depending upon distance traveled.

Manatee County

The Manatee County Transit System operated 15 motor buses and carried 830,412 passengers. Twelve smaller buses were used to provide demand responsive service to an additional 76,500 passengers. Service was provided 6 days a week on 115 miles of bus routes. There were 650,840 revenue vehicle miles of service and 42,366 vehicle hours of operation for the motor bus (fixed route) service. Corresponding figures for the demand responsive service were 433,500 and 20,400, respectively. The base fare was $0.50; half fares were available for elderly, handicapped, and students during mid-day hours (10 a.m. to 4 p.m.).

Monroe County

The Key West Transit Authority operated eight motor buses and carried 442,183 passengers. Service was provided 7 days a week on 725 miles of bus routes. There were 228,710 revenue vehicle miles and 19,976 vehicle hours of operation. The base fare was $0.50; half fares were given for elderly, handicapped, and students.

Pinellas County

The Central Pinellas Transit Authority operated 54 motor buses and carried 2,017,958 passengers on fixed route service. Nine smaller buses were used to provide demand responsive service to an additional 54,440 passengers. Service was provided 7 days a week on 494 miles of bus routes. There were 1,773,600 revenue vehicle miles and 114,580 vehicle hours of operation for the fixed route service. Corresponding figures for the demand responsive service were 94,200 and 9,420, respectively. The base fare was $0.40; half fare was provided for elderly and handicapped.

The St. Petersburg Municipal Transit System operated 64 motor buses and carried 7,423,800 passengers on fixed route service. Ten smaller buses were used to provide demand responsive service to an additional 52,534 passengers. Service was provided 7 days a week on 135 miles of bus routes. There were 2,414,400 revenue vehicle miles and 187,568 vehicle hours of operation for the fixed route buses. Corresponding figures for demand responsive service were 172,886 and 10,736, respectively. The base fare was $0.40; half fare was allowed for the elderly, handicapped, and students.

Sarasota County

The Sarasota County Area Transit (SCAT) operated 15 motor buses and carried 631,696 passengers. Service was provided 6 days a week on 139 miles of bus routes. There were 384,844 revenue vehicle miles and 26,436 vehicle hours of operation. The base fare was $0.50; half fares were charged to the elderly, handicapped, and students between 9:15 a.m. and 3:15 p.m. on weekdays.

A recent modification in Federal funding for municipal transport leaves the future of public transit uncertain in Southwest Florida. Under this modification, the operating cost subsidy currently funded through the Urban Mass Transportation Administration at half of the local revenue-cost deficit will be phased out during the next 3 years. To overcome the loss of Federal revenue, municipal governments could subsidize transit costs from other sources, increase fares, cancel non-profitable routes, or abandon bus service altogether.

PIPELINE TRANSPORT

PIPELINE NETWORKS

Major pipelines in Southwest Florida are privately owned and serve primarily for the transport of natural gas. The pipeline mileage, flows, and capacities in Southwest Florida are unknown, but the State as a whole is served by 2,952 mi of transmission lines and 8,839 mi of distribution lines. In 1975, the Florida consumption of natural gas was 307.3 billion ft^3 mostly provided by pipelines linking the State with domestic natural gas supplies in Texas and Louisiana.

PIPELINE OPERATIONS

Three major interstate natural gas pipeline companies supply Florida (Figure 4). Federal Power Commission and Department of Energy statistics do not reveal details on gas supply network characteristics or quantities for individual states. Total company operating statistics, each spanning at least three states, are shown in Table 11. Since no details at the State level or below are available, the extent of natural gas pipeline system operations within the 10-county Southwest Florida region is not known. Forecasts of pipeline shipment were not attempted due to the lack of baseline data.

Figure 4. Location of major pipelines in Florida (Florida Department of Transportation 1980b).

Table 11. Volume transmissions (thousands of cubic feet) of interstate natural gas pipeline companies in 1972-79 (Federal Power Commission 1973, 1974, 1975, 1976; U.S. Department of Energy 1975, 1979a, 1979b).

Year	Total gas receipts[a]	Total gas sales[b]	Total gas deliveries[c]	Miles of pipeline
Florida Gas Transmission Co. (FL, LA, TX, MS, AL)				
1972	270,492,577	129,051,889	270,498,878	4,258
1973	278,792,091	119,597,895	278,533,177	4,267
1974	260,933,617	113,741,953	260,872,810	4,266
1975	221,090,454	89,701,528	220,498,943	4,266
1976	222,077,746	83,870,423	222,376,033	4,267
1977	304,576,292	111,838,105	304,175,948	4,274
1978	325,830,621	133,648,528	325,551,497	4,279
1979	330,992,810	167,483,076	333,353,372	4,286
South Georgia Natural Gas Co. (AL, FL, GA)				
1972	26,564,543	26,264,664	26,443,883	769
1973	26,870,344	26,346,142	26,546,942	769
1974	27,017,390	26,688,104	26,850,936	769
1975	26,416,536	26,251,415	26,358,846	769
1976	23,417,633	23,358,396	23,407,068	770
1977	23,086,383	22,923,689	22,970,749	769
1978	26,034,367	26,011,046	26,097,197	649
1979	34,527,474	34,477,576	34,691,545	767
United Gas Pipeline Co. (AL, FL, LA, MS, TX)				
1972	1,619,737,415	1,206,494,644	1,626,340,487	7,308
1973	1,578,117,222	1,075,134,897	1,588,667,615	7,308
1974	1,423,021,563	958,252,704	1,421,077,322	7,339
1975	1,443,210,078	873,133,887	1,436,922,889	7,309
1976	1,440,613,038	824,831,820	1,430,264,088	5,784
1977	1,546,132,684	837,201,098	1,536,942,255	7,247
1978	1,566,555,814	823,576,366	1,559,374,027	7,267
1979	1,880,152,581	934,856,538	1,869,313,722	7,287

[a]Receipts: total volume received
Sales: total volume sold
Deliveries: total volume transported in pipeline

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RESIDENTIAL AND INDUSTRIAL DEVELOPMENT

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INTRODUCTION

Southwest Florida, one of the most rapidly growing areas in the State, is characterized by urban centers that sprawl outward over former farmlands, coastal areas laced with condominiums and time-sharing units, and residential developments rising out of the landscape almost everywhere. It consists of ten counties stretching from Pasco County in the north to Monroe County in the south and contains almost one-quarter of the State's population. Its population growth of 51.1% from 1970 to 1980 was greater than that of the State as a whole (43.4%).

Most of the population growth of Southwest Florida was and is along the coast in the Tampa Bay area, Sarasota, Venice, Port Charlotte, Fort Myers, Sanibel and Captiva Islands, Naples, and the Keys. Inland from the coast, growth and change are much slower, but still apparent. Much of this growth, whether on the coast or inland, is encoraching upon valuable natural environments.

Except for the Tampa Bay area, the growth in Southwest Florida is oriented toward recreation and retirement and associated services. If Outer Continental Shelf (OCS) oil and gas explorations find large oil reserves, onshore and harbor support facilities and operations for oil production would add to development of the coastal area and place new stress on the environment.

This report describes the characteristics of residential and industrial development in Southwest Florida, reviews the major public utilities that provide the support base for residential, industrial, and commercial development, and addresses the problems of point source pollution. These subjects are reviewed with particular emphasis on their capacity to support potential OCS oil and gas facilities and operations and their potential for altering the environment.

RESIDENTIAL DEVELOPMENT

During the 1970's, Fort Myers was the fastest growing metropolitan area in the country. Bradenton ranked 12th, Sarasota 16th, and Tampa/St. Petersburg 24th (Calonius 1981). Population growth in the ten counties comprising

Southwest Florida rose from 1,459,866 in 1970 to 2,206,231 in 1980 (U.S. Department of Commerce 1981a). Despite the rapid growth in population, the percent increase in housing construction was even greater. In 1970-80, the number of housing units in Southwest Florida rose to almost 1.2 million, an increase of 88%. The demand for housing may be even greater in the 1980's.

The demand for housing is especially important when considering the potential development of OCS oil and gas resources and its onshore effects. In this section, the characteristics of residential development are reviewed and housing demands are predicted.

GENERAL HOUSING TRENDS

Southwest Florida's share of housing units in the State has steadily increased since 1960. The share was 22% in 1950 and 1960, 25% in 1970, and 27% in 1980 (Table 1). The increase in the number of housing units was 221,000 in 1950-60, 197,000 in 1960-70, and 550,000 in 1970-80. The 1970-80 increase occurred during a relatively slow period of housing construction throughout most of the United States.

Table 1. The number (thousands) of housing units in Florida and Southwest Florida in 1950, 1960, 1970, and 1980 and the numerical increases in 1950-60, 1960-70, and 1970-80 (U.S. Department of Commerce, 1951, 1961, 1971, 1981a).

Area	Number of units				Numerical increase		
	1950	1960	1970	1980	1950-60	1960-70	1970-80
Florida	952	1,997	2,528	4,375	1,045	531	1,847
Southwest Florida	213	398	631	1,184	185	233	553
Percent share of State total	22.4	19.9	25.0	27.0	21.1	37.1	30.0

In 1950, Pinellas and Hillsborough County accounted for over 71% of all the housing units in Southwest Florida (38% in Hillsborough and 33% in Pinellas County), but by 1980 it decreased to only 54%. The decrease has been continuing since 1950 in Hillsborough County, but only since 1970 in Pinellas County. In the 1970's, the relative percent of housing units increased most significantly in Pasco and Lee Counties. The percentage increase for Pasco County is due, in large part, to the overflow of the Tampa/St. Petersburg urban area, whereas the increase for Lee County was more likely caused by new retirement and vacation home construction. Collier, Sarasota, Charlotte, and Manatee Counties showed somewhat less gain in their share of housing units in the region from 1970 to 1980. The decline of the percentage of housing units in Hillsborough and Pinellas Counties and the increase of the other counties is shown in Table 2.

Table 2. The number (thousands) of housing units in each of the counties and their percentage increase in Southwest Florida in 1950 to 1980 (U.S. Department of Commerce, 1961, 1971, 1981a).

County	Number of housing units (thousands)				Percent increase		
	1950	1960	1970	1980	1950-60	1960-70	1970-80
Charlotte	2.2	6.2	13.8	33.5	2.2	3.3	3.6
Collier	2.3	6.0	17.6	50.6	2.0	5.0	6.0
DeSoto	2.7	3.4	4.1	7.9	0.4	0.4	0.7
Hillsborough	81.4	123.2	168.6	263.8	22.6	19.5	17.5
Lee	9.0	21.0	43.5	111.2	6.5	9.7	12.2
Manatee	14.6	30.3	42.8	84.5	8.5	5.4	7.5
Monroe	8.4	16.7	20.7	37.3	4.5	1.7	3.0
Pasco	7.7	14.9	34.8	99.4	3.9	8.6	11.7
Pinellas	71.2	141.8	228.8	382.1	38.2	37.4	27.7
Sarasota	13.7	34.8	56.2	113.7	11.4	9.2	10.4
Totals	213.2	398.3	630.9	1,184.0	100	100	100

DISTRIBUTION

The population of Southwest Florida is concentrated in the coastal cities of Clearwater, St. Petersburg, Tampa, Bradenton, Sarasota, Fort Myers, Naples, and Key West. The beachfront, bayfront, or barrier islands near these cities are heavily populated.

Although a number of rapidly growing communities, like Dade City, are located in the eastern portion of Pasco County, most of the development has been in the western, coastal portion, especially adjacent to U.S. Highway 19, which runs in a north-south direction.

Most of Pinellas County is developed. The major residential areas are in St. Petersburg, Clearwater, and the barrier islands.

Residential development in Hillsborough County is concentrated in or near Tampa (Figure 1), but other rather extensive development is apparent in Brandon and Plant City, east of Tampa. New residential and industrial areas are developing rapidly along the eastern shore of Tampa Bay.

Virtually all of the residential development in Manatee County is along the coast and barrier islands. Bradenton is the only sizable city.

The barrier islands and the coastal area of Sarasota County are heavily populated. The County's largest cities are Sarasota, Venice, and Englewood. Housing development is concentrated along Highway U.S. 41, which parallels the coast. DeSoto County is primarily rural; most of its residential development is in the community of Arcadia.

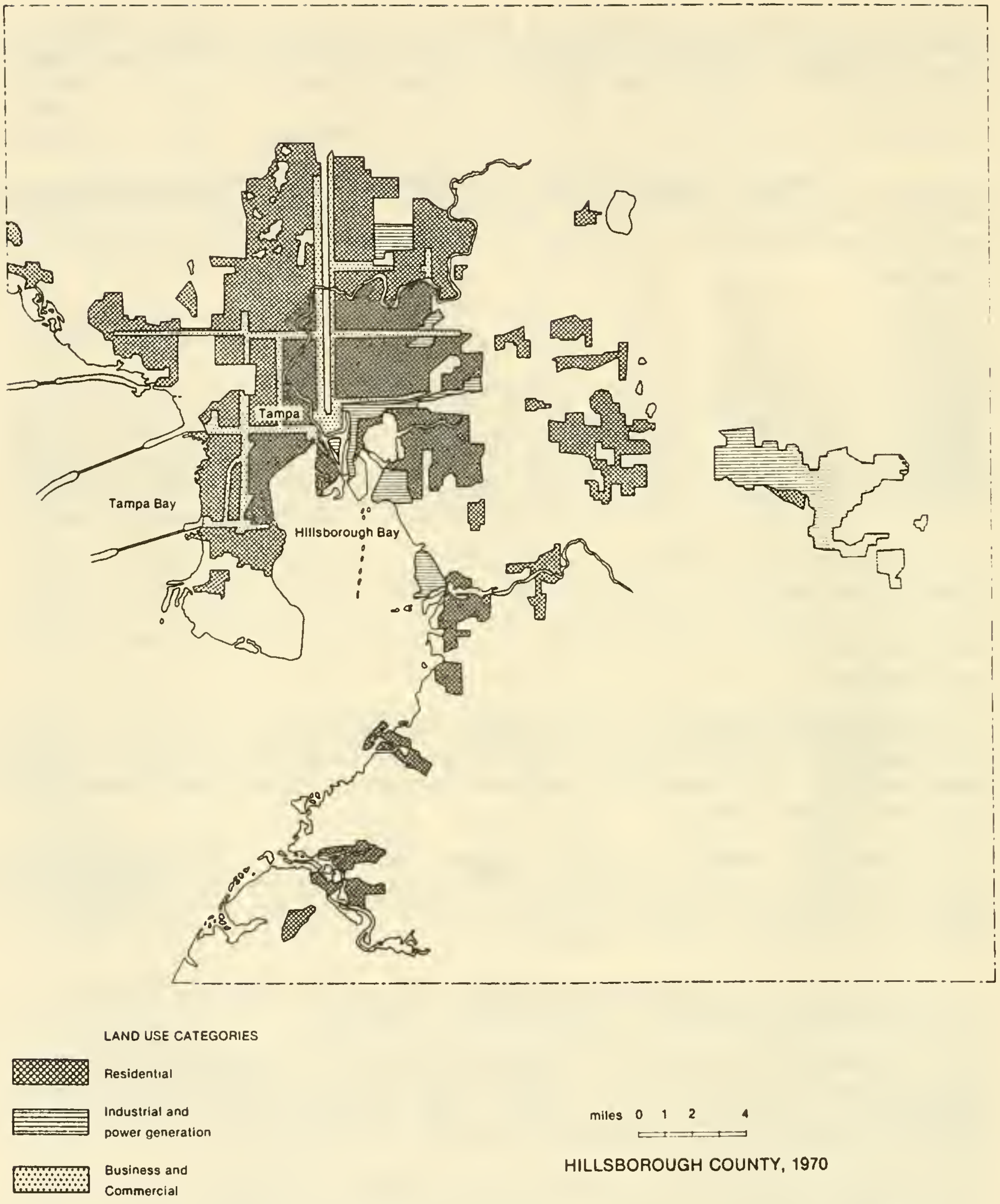


Figure 1. Land use categories in Hillsborough County (Florida Coastal Coordinating Council 1970).

Charlotte County is the site of many new residential and retirement communities. Its pattern of development reflects an extension of coastal corridor south of Sarasota County, plus a low-density sprawl in the upper reaches of Charlotte Harbor. Punta Gorda and Port Charlotte, the two major communities in the county, are located at the north end of the harbor.

Lee County is one of the fastest growing urban areas in the Nation. Its principal centers, Fort Myers and sprawling Cape Coral are becoming the focal point of extreme southwest Florida. New activities, such as a branch campus of the University of South Florida in Fort Myers, are being brought into the area. The growth of Fort Myers will probably continue through the 1980's and beyond, and it should become a major urban center in Florida.

As among other coastal counties of Southwest Florida, there is extensive residential development on the barrier islands of Lee County. The residents of Sanibel Island, which already is heavily developed, have adopted a stringent growth management program in an attempt to halt overdevelopment.

Collier County also is growing rapidly, primarily along the coast from Naples northward. Expansion in the eastern portion of the county is restricted because most of that area is within the Big Cypress National Preserve. Marco Island is the largest and most developed of Collier County's coastal islands. A number of small, mostly unpopulated islands extend southeastward to the Everglades National Park.

Although most of the land area of Monroe County is on the southwestern tip of the Florida peninsula, the county is best known for the Keys, a string of islands extending about 120 miles from the mainland to Key West. Other than for the Keys, the county is almost totally within the Everglades National Park and Big Cypress National Preserve.

Except in Pinellas, Hillsborough, and Pasco Counties, high-density housing developments in Southwest Florida hug the coast. This trend is likely to continue until the coastal zone is saturated with urban and suburban development or until more coastal communities adopt and rigidly enforce zoning regulations. In either case, further residential development would probably move inland, except in Collier County where eastward development and in Monroe County where mainland development is restricted by federally owned swamplands. According to Florida Trend magazine, eastward expansion is rather inevitable because enough lots already have been sold in southwest Florida to house one million more people by the year 2000. Residential construction on these lots alone would double the population (Levin 1981). Should this growth actually materialize, much of it would probably be concentrated adjacent to Interstate 75.

TRENDS FOR SPECIFIC TYPES OF RESIDENTIAL DEVELOPMENT

This section on residential development in Southwest Florida describes the characteristics of detached single-family dwellings and multifamily units.

Detached Single-family Dwellings

In 1975-79, Pinellas and Hillsborough Counties issued the greatest percentages of permits (23.8% and 23.5%, respectively) for detached single-family dwellings in the ten county area (Table 3). The next largest contributors were Sarasota County (13.9%), Pasco County (9.8%), and Lee County (8.8%). In 1975, 10,907 building permits were issued in Southwest Florida, but in 1977, the number doubled to 25,169. Although the number of permits issued in 1979 was even greater than in 1977, the rate of increase was lower.

Table 3. Number of single-family building permits issued and their percent contribution among the counties of Southwest Florida in 1975, 1977, and 1979 (Thompson et al. 1976, 1978, 1980).

County	Number of permits			Percent contribution
	1975	1977	1979	1979
Charlotte	443	1,326	1,517	5.2
Collier	603	1,697	1,523	5.3
DeSoto	100	97	173	0.6
Hillsborough	2,409	5,115	6,635	23.1
Lee	1,629	3,326	3,205	11.1
Manatee	554	1,245	1,920	6.6
Monroe	278	371	475	1.6
Pasco	2,005	4,091	3,765	13.0
Pinellas	1,589	4,691	5,871	20.4
Sarasota	1,297	3,210	3,794	13.9
Total	10,907	25,169	28,878	100.0

Mobile Homes

Many people, especially retirees, seek low income housing. The mobile home has become a popular answer to this need in much of Florida, especially in Southwest Florida. In 1970, the ten counties accounted for 38% of the mobile homes registered in the State. This was a slight increase over 35% in 1950.

In 1970, the United States Census reported 129 mobile homes in the unincorporated (rural) areas of Calhoun County, whereas only 65 mobile homes were listed on the tax rolls, an error of 50.3%. In a 1974 aerial photo survey, 293 mobile homes were identified, but only 145 (49%) were reported on in the tax rolls (Hager and RuBino 1978). It is apparent that tax records usually are a poor source of data, but records in the more urbanized counties probably are more accurate than in rural counties.

The housing censuses for 1950, 1960, and 1970 show that Pinellas County has over one-third of the mobile homes in Southwest Florida (Table 4). The next largest share is in Hillsborough County. These two counties have over half of the mobile homes, but their percentage of the ten county total is declining. The other eight counties have had sizable increases in the number of mobile homes; Charlotte and Monroe Counties are exceptions. Census data after 1970 are not yet available.

Table 4. Number of mobile homes in the counties of Southwest Florida in 1950, 1960, and 1970 (U.S. Department of Commerce 1961, 1971).

County	1950	1960	1970
Charlotte	111	620	1,385
Collier	95	362	1,782
DeSoto	30	106	326
Hillsborough	1,790	5,658	11,380
Lee	209	1,401	5,213
Manatee	---[a]	---	---
Monroe	---	---	---
Pasco	132	1,241	5,807
Pinellas	2,670	8,367	22,042
Sarasota	679	1,870	5,693
Southwest Florida	---	---	---
Florida	19,592	65,087	172,100

[a]Data not immediately available (---).

Multi-family Dwelling Units

The multi-family building permits authorized from 1975 to 1979 for Southwest Florida (Table 5) show that the percentage of multi-family units in Southwest Florida is low for Pinellas County (20%) and Hillsborough County (17%). These percentages are low because much of the retiree-oriented residential development started before the construction of multi-family structures for retirees and vacationers (e.g., time-sharing units) become popular; consequently, a large portion of retirees are housed in mobile homes and other single-family structures. This is probably true, but to a lesser extent, in Hillsborough County where the economic base is more diversified. The proportion of multi-family homes in DeSoto County is small and single-family homes predominate because it is an inland, agriculturally-oriented county usually overlooked by retirees and tourists. In the other counties, the percentage of multi-family homes to single-family homes is higher because their residential growth better reflects recent trends toward multi-family rental and condominium housing.

Table 5. Number of multi-family dwelling unit permits issued and their percent distribution among the counties of Southwest Florida in 1975-79 (Thompson et al. 1976, 1977, 1980).

County	Number of permits	Percent
Charlotte	3,905	3.8
Collier	9,602	9.4
DeSoto	421	0.4
Hillsborough	17,813	17.5
Lee	16,013	15.8
Manatee	8,368	8.2
Monroe	1,546	1.5
Pasco	11,299	11.1
Pinellas	20,442	20.2
Sarasota	12,254	12.1
Region	101,663	100.0

Residential development probably will continue to increase in Southwest Florida, and the percentage of multi-family dwelling units will increase accordingly in all but Charlotte, DeSoto, and Monroe Counties.

Condominiums, Cooperatives, and Time-sharing Units

In Southwest Florida, multi-family units are condominiums, cooperatives, and time-sharing units. The proportion of rental units among them vary considerably. Assessments of the availability of rental space must differentiate among kinds of multi-family structures. Such evaluations may be particularly important if OCS oil and gas development bring a new flux of workers and demand for housing. Rental data on condominiums and cooperatives have been difficult to find and have complicated the problem of accurately assessing rental space.

Quality of Housing

Since the 1960 Census, the quality of housing has been measured primarily by the kind and number of plumbing facilities in the housing units. In 1960-70, the percentage of housing units in Southwest Florida without plumbing decreased from 13.0% to 3.4% (Table 6). Only DeSoto County still has a relatively high percentage (13.5%) of housing units without plumbing. Although census data are not yet available for 1980, it is assumed that the quality of housing in all of the counties has improved considerably.

Table 6. Percent of housing units lacking all or some plumbing in the counties of Southwest Florida in 1960 and 1970 (U.S. Department of Commerce 1961, 1971).

County	1960	1970
Charlotte	12.5	2.3
Collier	23.9	5.4
DeSoto	36.8	13.5
Hillsborough	18.9	4.4
Lee	17.3	3.9
Manatee	13.6	3.9
Monroe	18.9	5.0
Pasco	19.9	4.2
Pinellas	6.5	2.3
Sarasota	8.0	1.2
Southwest Florida	13.0	3.4

Price Range of Housing Units for Sale

Census data for 1980 on the median value of housing units for sale are not yet available. The data would be helpful because a review of the general price range of housing units for sale provides potential residents with an idea of what proportion of their income must be allocated to housing. This would be of particular interest if any of the counties in Southwest Florida were to have residential development caused largely by OCS oil and gas exploration and development. The concern is greatest in the rurual or less populated counties than for Pinellas and Hillsborough Counties, which have a broader and more ample range of housing.

Although Table 7 does not contain information for 1980, it does provide a comparison of the trend in median value of housing units for some counties and a comparison of the 1970 median values among the counties. In 1970, the highest median value was $30,700 in Collier County. Other median values were $21,600 for Lee County, $17,800 for Monroe County, and $12,000 for Pasco County. DeSoto County's median value was the lowest, near $5,000.

In the 1980's, housing costs undoubtedly will continue to rise, particularly in fast-growing Pasco, Hernando, Lee, and Collier Counties. Contributing to increasing costs are high interest rates and also impact fees, which are flat sums paid by purchasers of new housing units to offset costs of new public roads, sewers, water systems and other facilities or services. This method of covering the costs of public services has been adopted by a number of local governments throughout south Florida.

Table 7. Median values (in dollars) of housing units for sale in the counties of Southwest Florida in 1950, 1960, and 1970 (U.S. Department of Commerce 1961, 1971, 1981a).

County	1950[a]	1960[b]	1970
Charlotte	--	9,600	14,600
Collier	--	--	30,700
DeSoto	--	--	5,000
Hillsborough	7,016	11,100	10,800
Lee	--	13,400	21,600
Manatee	--	134,200	16,300
Monroe	--	--	17,800
Pasco	--	8,900	12,000
Pinellas	9,765	13,400	14,000
Sarasota	10,632	14,500	17,000
Southwest Florida	9,138[c]	12,014[c]	15,980

[a]Median value not shown where base is less than 100.
[b]Median value not shown where base is less than 200.
[c]Median value does not include counties for which data are not given.

Rental Units

In 1970, almost one-third of the housing units in Florida were rentals whereas only one-fourth of the units in Southwest Florida were rentals. The demand for higher priced homes and condominiums in this part of Florida is so great and profits so attractive that developers opt for building luxury class homes rather than the less profitable moderate and lower priced homes and apartments (Crew 1978). Among the ten counties, Monroe had the highest percentage (43.6%) of rental units (Table 8).

The percentage of rentals among residences ranged from 15% to 29% among the counties of Southwest Florida. The lowest percentages were in Pasco (14.7%) and Charlotte (15.5%) Counties. In Naples (Charlotte County), the rental problem is particularly acute because many renters now spend as much as 40% or more of their income for housing (Crew 1978).

If the conversion of apartments to condominiums in Southwest Florida was as rapid as in the Miami-Fort Lauderdale area, the percentage of rental units would likely decrease in most counties except Monroe County, where the economy depends heavily on tourists, and DeSoto County, which will probably remain rural for some time. If sizable oil and gas reserves were discovered, the decline in available rental units would be of concern among workers who might be expected to move into the area.

Table 8. Number of housing units and the number and percent of rental units among the counties of Southwest Florida in 1970 (U.S. Department of Commerce 1971).

County	Number of units	Number of rentals	Percent rentals
Charlotte	13,752	2,130	15.5
Collier	17,580	4,757	27.1
DeSoto	4,095	1,200	29.3
Hillsborough	168,555	47,496	28.2
Lee	43,511	11,204	25.7
Manatee	42,794	8,977	21.0
Monroe	20,727	9,035	43.6
Pasco	34,816	5,132	14.7
Pinellas	228,771	58,095	25.4
Sarasota	56,242	12,111	21.7
Southwest Florida	630,843	160,137	25.2

Rental Rates

In 1977, only Collier and Sarasota Counties had an average monthly rent ($171) that was above the State average of $157. Pinellas County, the most heavily populated county in the region, had the lowest monthly rent ($131). Perhaps this is a reflection of the inability of retirees to pay high rents.

Vacancies

Southwest Florida's share of the total number of housing units in the State was about 25% in 1960 and 1970, but the percentage of vacancies decreased from 28% to 25% (Table 9). Although the census data for 1980 are not yet available, the percentage of total units in the region as compared to the State probably increased during the last decade, whereas the percentage of vacancies probably changed little.

In 1950-70, Pinellas County had the greatest number of seasonal and year-round vacancies (Table 10). Hillsborough County also had many vacant units, but seasonal vacancies were much less common. These observations seem to support other data that infer that Hillsborough County is becoming less dependent on the tourist industry and more like other metropolitan areas. A rather startling rise in vacant seasonal housing was observed in Collier County; in 1950, the county had 21 vacant seasonal units, in 1960 it had 676, and in 1970 it had 1,499 (the second largest county total in Southwest Florida).

Table 9. The number of housing units in Southwest Florida in 1950, 1960, and 1970 and their percent of the State totals in parentheses (U.S. Department of Commerce 1951, 1961, 1971).

Items	1950	1968	1970
<u>Housing units</u>			
Southwest Florida	213,173	434,488	630,843
Florida	952,131	1,996,961	2,526,536
	(22.4)	(24.5)	(25.0)
<u>Vacancies</u>[a]			
Southwest Florida	26,771	63,422	60,558
Florida	111,458	226,547	241,826
	(24.0)	(28.0)	(25.0)

[a]Includes both vacant year-round units and vacant seasonal and migratory units.

PROJECTED TRENDS IN HOUSING

In 1980-2000 projected number of housing units for each county in Southwest Florida (Table 11) was calculated by taking the number of persons per housing unit (U.S. Department of Commerce 1981a) and extrapolating on the basis of population projections provided by the Florida Department of Commerce (1979). In 1977, for example, the Bureau of Economic Research estimated that Charlotte County would have a population of 50,800 in 1980, 68,500 in 1990, and 79,600 in 2000. Since the actual 1980 census for Charlotte County was 59,115, the other estimates were adjusted to 78,348 in 1990 and 90,973 in 2000. In these projections it was assumed that the average number of persons per housing unit would remain substantially the same as in 1980 (e.g., 1.7 for Charlotte County). In this case, 1.7 was divided into the projections and the number of housing units for Charlotte County was estimated at 46,087 in 1990 and 53,514 in 2000.

DATA GAPS AND RECOMMENDED SOLUTIONS

A serious problem concerning residential development in Southwest Florida is that of differentiating between housing units being used by permanent residents and housing units used for temporary residents and tourists. If the latter were merely a matter of motel and hotel rooms, this would not be a problem, but many vacationers rent single-family homes and units in multifamily dwellings for a week, a month, or a season. In addition, an increasing number of people are now purchasing time-sharing units on a weekly or biweekly basis. Information on time-sharing units is not contained in the census

Table 10. Number of year-round and seasonal vacancies in housing units in the counties of Southwest Florida in 1950, 1960, and 1970 (U.S. Department of Commerce 1951, 1961, 1971).

County	1950			1960			1970		
	Vacant year-round units	Vacant seasonal units	Total vacant units	Vacant year-round units	Vacant seasonal units	Total vacant units	Vacant year-round units	Vacant seasonal units	Total vacant units
Charlotte	409	127	536	843	646	1,489	1,378	706	2,084
Collier	257	21	278	424	676	1,100	3,069	1,499	4,568
DeSoto	209	24	233	245	104	349	143	17	160
Hillsborough	5,174	672	5,846	10,270	1,978	12,248	9,542	263	9,805
Lee	986	417	1,403	1,456	1,864	3,320	4,883	1,315	6,198
Manatee	1,290	1,329	2,619	3,202	2,479	5,681	3,301	1,005	4,306
Monroe	882	92	974	1,795	1,182	2,977	3,110	794	3,904
Pasco	811	287	1,098	1,953	615	2,568	3,840	615	4,455
Pinellas	7,755	2,875	10,630	16,454	7,544	23,998	14,243	3,227	17,470
Sarasota	2,410	748	3,158	4,589	2,535	7,124	6,302	1,306	7,608
Southwest Florida	20,183	6,592	26,775	41,231	19,623	60,854	49,811	10,747	60,558
Florida	86,337	25,121	111,458	163,016	63,531	226,547	204,182	37,644	241,826

or in State records; most surveys include these as housing units without making distinctions of specific use. Short of an examination of all of the original census sheets (which may or may not contain this information), or an analysis of county tax assessments, these data will remain obscure.

Table 11. Average number of persons per housing unit and the projected number of housing units in the counties of Southwest Florida in 1980, 1990, and 2000.

County	Number of persons per housing unit	1980	1990	2000
Charlotte	1.7	35,514	46,087	53,514
Collier	1.7	50,779	68,513	79,596
DeSoto	2.6	7,458	9,312	10,823
Hillsborough	2.5	263,619	317,040	367,334
Lee	1.8	111,013	151,639	176,125
Manatee	1.8	83,586	103,489	120,227
Monroe	1.7	38,088	42,155	48,965
Pasco	1.9	101,172	139,633	162,176
Pinellas	1.9	376,971	479,683	557,208
Sarasota	1.8	113,355	143,866	167,096
Southwest Florida	2.0	1,181,555	1,501,417	1,743,064

Time-sharing units are important in Southwest Florida because most of them are located immediately adjacent to the coast, and data pertaining to them could shed light on the availability of housing to workers who might be associated with potential OCS oil and gas development. Depending on the situation, condominiums and cooperatives may be suitable for OCS workers, but time-sharing units likely would not be available, or preferred even if available.

INDUSTRIAL DEVELOPMENT

Industrial development in Southwest Florida is confined largely to the Tampa Bay area in Hillsborough and Pinellas Counties and to Fort Myers. A number of manufacturing industries are scattered throughout Pinellas County from St. Petersburg to Clearwater, most of which are in low-lying areas subject to floods and storm surge. In Hillsborough County (Figure 1), industrial lands are concentrated in the eastern outskirts of Tampa, the eastern shore of Tampa Bay, and in the Plant City area (an unincorporated area in the eastern part of the county).

All of the counties have some manufacturing industries, but the land area involved is relatively small. Most of the better lands for development are being used to provide housing for tourists and retirees. Although industrial

development is needed in this area to help diversify its economic base, the lack of an appropriate labor force, an ample supply of fresh water, and numerous environmental problems will probably restrict industrial development to large urban areas like Fort Myers and Sarasota.

The following section describes the industrial development from a historical perspective, general site characteristics, projected trends, and potential for onshore development from OCS oil and gas activities, and related environmental impacts.

TRENDS IN INDUSTRY

Hillsborough and Pinellas Counties are two of the most industrialized counties in Florida. Among the counties in the State, they rank third and fourth, respectively, in manufacturing employment (Table 12). The dominance of these two counties in Southwest Florida is demonstrated by their contribution of 64% of the total employment and 76% of the employment in manufacturing.

The relative importance of employment in manufacturing as a percentage of total employment is low for most of the counties in Southwest Florida (Table 13). The Statewide percentage of 11.1, which is low compared to many other states, is exceeded only by Manatee County (13%), Hillsborough County (13%), and Pinellas County (12%). Manatee County has the highest employment in manufacturing in Southwest Florida.

The greatest increases in percent change in employment in manufacturing were in Collier (140%) and Lee (109%) Counties (Table 13). Considering that these counties had relatively few employees in manufacturing in 1978, this percent gain is unimportant. Hillsborough County had the greatest number of employees in manufacturing, but in terms of percentage change in manufacturing from 1970-79, employment increased only 16.1%, one of the lowest gains among the counties in the area. DeSoto County was the only county in the region that recorded a loss (-3.4%). Descriptions of the industrial base of the counties in Southwest Florida are given in alphabetical order in the following subsections and in Table 14.

Charlotte County

Like other counties in Southwest Florida, the main nonagricultural employment categories in Charlotte County are retail trade and services. Almost two-thirds of the people employed in services worked in health services, which is a reflection of the high proportion of elderly and retired people in the county.

Collier County

Retail trade is the largest source of nonagricultural employment in Collier County. About a third of the workers in this category are employed in eating and drinking establishments. Services support the second largest number of employees.

Table 12. Number of employees in construction and manufacturing industries in 1978 and rank among Florida counties (Florida Department of Commerce, Division of Economic Development 1979).

County	Numbers employed	Rank	Construction	Rank	Manufacturing	Rank
Charlotte	14,588	33	1,562	24	303	57
Collier	30,898	23	3,143	14	884	39
DeSoto	8,277	43	--	60	346	54
Hillsborough	289,520	4	14,858	5	36,865	3
Lee	69,068	14	7,303	9	3,625	19
Manatee	48,491	16	3,115	15	6,460	13
Monroe	26,772	25	1,318	26	824	13
Pasco	36,135	22	2,765	18	2,868	23
Pinellas	250,528	5	15,927	3	29,366	4
Sarasota	75,447	12	6,970	10	5,832	14
Southwest Florida	849,724	--	56,861	--	87,374	--
Florida	3,829,604	--	208,561	--	419,561	--

Table 13. The percent of employees in manufacturing in the counties of Southwest Florida and the State total, and the percent change of employment in manufacturing from 1970 to 1980 (Florida Department of Commerce, Division of Economic Development 1980).

County	Percent contribution to the State total	Percent change in employment in manufacturing
Charlotte	2.1	75.1
Collier	2.9	139.6
DeSoto	4.2	-3.4
Hillsborough	12.7	16.1
Lee	5.2	108.6
Manatee	13.3	41.7
Monroe	3.1	75.7
Pasco	7.9	73.5
Pinellas	11.7	36.5
Sarasota	7.7	60.7
Florida	11.1	--

DeSoto County

In 1979, DeSoto County had only about 2,300 employees in non-agricultural activities. The largest share (36.7%) was in retail trade; manufacturing accounted for about 17%.

Hillsborough County

Hillsborough County is the most industrialized county in the region, however, employment in manufacturing still ranked behind employment in services and in retail trade. Government employment probably would have ranked relatively high if the data were available.

Lee County

The major employment categories in Lee County in 1979 were in retail trade and services, followed by construction, finance, insurance, real estate, and manufacturing. Retail trade and services reflect the importance of recreation and retirement to the economy of the county. This is a rapidly growing county, and continual increases in manufacturing would help to diversify its economic base.

Manatee County

Like most Southwest Florida counties, Manatee County ranked one and two in number of employees in retail trade and services, manufacturing accounted for a relatively sizeable proportion (16%) of the non-agricultural employment.

Table 14. Number of non-agricultural employees (excluding government) in the counties of Southwest Florida in 1979 (U.S. Department of Commerce 1981).

County	Manu-facturing	Transportation and public utilities	Wholesale trade	Retail trade	Finance insurance and real estate	Services	Construc-tion
Charlotte	370	430	170	3,516	1,505	2,603	2,152
Collier	645	1,013	1,057	8,080	2,187	6,187	3,750
DeSoto	414	73	284	918	216	315	95
Hillsborough	35,964	15,768	22,371	49,314	15,456	54,151	18,410
Lee	3,804	3,539	2,621	16,606	5,042	12,511	8,810
Manatee	5,255	1,261	1,212	10,800	2,718	7,335	3,365
Monroe	837	1,062	734	5,965	1,327	4,905	1,610
Pasco	3,930	1,534	620	7,689	1,936	6,464	3,310
Pinellas	33,091	8,379	8,702	56,874	18,225	60,716	18,254
Sarasota	7,137	3,066	2,246	19,354	4,842	15,936	8,367

Monroe County

In Monroe County, which depends heavily on tourism, retail trade and services (especially motels and lodging facilities) accounted for 66% of the total non-agricultural employment (excluding government) in 1979. Manufacturing employed only 837 people.

Pasco County

Pasco County, just north of Pinellas and Hillsborough Counties, is developing rapidly and its western portion has many of the retirement and recreation characteristics shown by Pinellas County. Its central and eastern portions are spillover areas for Hillsborough County, so this area is similar in some respects to the Tampa area. In 1979, the major fields of employment were retail trade, services, and manufacturing.

Pinellas County

In Pinellas County, 33,091 people were employed in manufacturing in 1979. This was exceeded only by retail trade and services. Over one-third of the service workers in the county were employed in health-related fields; most likely a consequence of the large number of retirees.

Sarasota County

Retail trade and services accounted for the majority of the non-agricultural jobs in Sarasota County and reflect the county's dependence on tourism, recreation, and retirement. The next largest categories of employment were construction and manufacturing.

RECENT INDUSTRIAL DEVELOPMENT

The types of industries that have located or expanded in the counties of Southwest Florida in 1970-80 are discussed in the following subsections. A list of these new industries or expansions by county, city, and type of manufacturing is given in Table 15.

Charlotte, Collier, and DeSoto Counties

No new industrial plants or expansions were reported for Charlotte County in the 1970's. In 1974, a concrete block and ready-mix plant was located in Naples (Collier County) to serve the growing residential development. In the more agriculturally oriented DeSoto County, a citrus processing plant (1978) and a asphalt plant (1980) were opened in Arcadia.

Hillsborough County

In 1970-80, thirty-seven new industries located in Hillsborough County and six manufacturing firms expanded their floor space. Thirty-one of the new plants were in Tampa and the other six in Plant City. All of the expansions were in Tampa. The construction of 16 new plants in 1979 and 1980 may be a forerunner of new industrial growth in the county. Several of the industries listed in Table 15 could be used or converted to supply the needs of OCS oil

Table 15. New industries and expansions in Southwest Florida in 1970-80 (Industrial Development Research Council 1977-80).

County	City	Type of industry	New plant	Expansion	Year
Charlotte		None			
Collier	Naples	Concrete blocks, ready mix	x		1974
DeSoto	Arcadia	Citrus processing	x		1978
		Asphalt	x		1980
Hillsborough	Plant City	Aluminum extrusion products	x		1970
	Tampa	Optical machinery, lenses	x		1970
		Cigars	x		1970
		Industrial furnaces	x		1971
		Hydrofluosilicic acid	x		1971
		Superphosphate plant	x		1971
		Aluminum cans (beer)	x		1972
	Plant City	Phosphate fertilizer	x		1972
	Tampa	Terminal for handling phosphate fertilizers	x		1973
		Process clinker	x		1973
		Cold storage warehouse	x		1973
		Grocery store warehouse and headquarters	x		1974
		Corrugated shipping containers		x	1974
		Grain storage	x		1974
		Meat processing	x		1974
		Pressurizers for nuclear power plants, steam generators		x	1974
	Plant City	Modular classrooms		x	1975
	Tampa	Isocronous governors, couplings (boats)	x		1975
		Barges	x		1975
		Port terminal for fertilizer storage, shipping	x		1976
		Yachts	x		1976
		Insulation		x	1977
	Plant City	Metal belt conveyors, special industrial machinery	x		1977
	Tampa	Uranium recovery from phosphoric acid	x		1977
		Shrimp processing		x	1978
		Electronic microprocessor, fiber optic equipment	x		1979

(continued)

Table 15. (Continued).

County	City	Type of industry	New plant	Expansion	Year
Hillsborough	Tampa	Flight simulators, training devices	x		1979
		Aluminum sheet & foil	x		1979
		Paper bags	x		1979
		Electronic assembly	x		1979
		IBM engineering center	x		1979
		Airline operations center	x		1979
		Distribution center	x		1979
		Electronic components	x		1980
		Wooden beds	x		1980
		Data processing	x		1980
		Data processing		x	1980
		Electronic medical monitoring equipment	x		1980
	Plant City	Vegetation processing	x		1980
		Mobile homes	x		1980
	Tampa	Citrus processing	x		1980
		Aircraft, engine parts	x		1980
		Phosphoric acid		x	1980
Lee	Fort Myers	Crushed limestone	x		1972
		Aircraft filters, air and water purification equipment	x		1976
		Rub-off tape	x		1978
		Newspaper		x	1979
Manatee	Bradenton	Clay pipes	x		1973
		Welding machines	x		1974
		Oil unloading station, pipeline & refinery	x		1974
	Port Manatee	Clean fuels processing	x		1974
	Bradenton	Phosphate rock beneficiation	x		1975
		Aircraft switches	x		1978
		Mirrors	x		1979
		Cutting tips	x		1980
Monroe	Key West	Shrimp processing and packing	x		1977
Pasco	Lacoochee	Concrete pressure pipes	x		1974
	New Port Richey	Taps, dies, gauges	x		1978
		Bakery machinery	x		1979
		Plastic bottles	x		1980
Pinellas	Clearwater	Electronic assembly	x		1975
	Saint Petersburg	Microwave equipment	x		1975

(continued)

Table 15. (Continued).

County	City	Type of industry	New plant	Expansion	Year
Pinellas	Clearwater	Metal watch bands	x		1975
	Saint Petersburg	Telephone directory		x	1975
		Airplanes	x		1977
	Tarpon Springs	Sponges, sheepskins	x		1977
	Clearwater	Window & door guards	x		1978
	Tarpon Springs	Packaging machines		x	1978
	Saint Petersburg	Microwave equipment		x	1978
	Clearwater	Sail and power boats		x	1978
	Saint Petersburg	Aircraft filters		x	1978
		Plastic lenses		x	1978
		Electric terminals and component parts	x		1979
	Largo	Data communication systems		x	1979
	Clearwater	Bomar Instruments[a]	x		1979
		Eva-Tone Evatype	x		1979
		Hytronics	x		1979
		Tanko Screw Products	x		1979
		Technapac	x		1979
		Cosco		x	1979
		Dynamet		x	1979
		Pacemaker furniture	x		1979
	Largo	Atlantic	x		1979
	Oldsmar	Gilco	x		1979
		Godfrey Engineering	x		1979
	Pinellas Park	Swanson H&S Tool	x		1979
	Saint Petersburg	Buffalo Medical Speciality	x		1979
		Farmer Mold and Machine Works	x		1979
		Hamilton Avnet Electronics	x		1979
		King Electronics	x		1979
	Largo	Big Sunitral		x	1979
		Fl Gulf Coast Industries		x	1979
	Pinellas Park	ABA Industries		x	1979

(continued)

Table 15. (Concluded).

County	City	Type of industry	New plant	Expansion	Year
Pinellas	Saint Petersburg	Action Ads	x		1979
		Laminated/coated film		x	1979
		Freight carriers terminal	x		1979
	Clearwater	Optical instruments	x		1979
		Textile machinery	x		1979
	Saint Petersburg	Pharmaceuticals	x		1979
	Largo	Construction components	x		1979
	Saint Petersburg	Electronic bottle inspection equipment	x		1980
		Welding equipment	x		1980
		Switch boards	x		1980
		Metal and plastic valves	x		1980
		Aircraft overhauling	x		1980
		Gold jewelry	x		1980
	Clearwater	Precision instruments, industrial equipment	x		1980
	Oldsmar	Commercial printing	x		1980
	Saint Petersburg	Bottle closures	x		1980
		G T E[b]		x	1980
	Largo	Wholesale distribution center	x		1980
		Mobile homes	x		1980
	Pinellas Park	Square D Co[b]	x		1980
	Saint Petersburg	Leather goods	x		1980
		Liquid chromatography		x	1980
		Military aircraft		x	1980
Sarasota	Sarasota	Telemetry mounting and control equipment	x		1978
		Fiberglass boats		x	1979

[a]From Bomar Instruments, Action Ads (p. 5)
[b]The type of industry was not named; names of firms are substituted.

and gas exploration and production. Among them are aluminum extrusion products, barges, and metal belt conveyors.

Lee County

Fort Myers had only three new industries and one expansion in 1970-80. The county is mostly residential, and industrial plants are scarce.

Manatee County

Eight new industries have located in Manatee County since 1970. Several industries manufacture items or materials that could be used or converted to be used for OCS oil and gas exploration and production. Examples are welding machines, clay pipes, oil unloading stations, pipelines, and cutting tips.

Monroe County

A shrimp processing and packing plant was opened in Key West in 1977.

Pasco County

Three new industries were built in New Port Richey in 1978-80. One other industry was built in Lacoochee in 1974.

Pinellas County

Fifty new industries and 16 expansions were reported for Pinellas County in the 1970's. These industries were distributed mainly in Clearwater, St. Petersburg, Tarpon Springs, Largo, Oldsmar, and Pinellas Park. As in Hillsborough and Manatee Counties, the products of several industries may be usable for OCS oil and gas exploration and production.

Sarasota County

One new industry located in Sarasota County in 1978, and one industry expanded in 1979.

GENERAL SITE CHARACTERISTICS AND ISSUES

Future industrial growth in Southwest Florida will depend upon a variety of factors including the availability of water, electrical power and other public utilities, materials, transportation, markets, and manpower. Most of these factors are discussed in other chapters, except for public utilities, which is described in the following section of this chapter.

Generally, new industries require the following criteria for locating a plant (Lochmoeller 1975):

(1) Major metropolitan areas that have the expectation of substantial population and economic growth.

(2) The site is served by either an existing expressway system or one planned for construction.

(3) Ready access to highways, airports, or seaports.

(4) Favorable community attitudes toward industry.

(5) Potential for new and expanding industries.

On the basis of these criteria, future industrial development in Southwest Florida will probably continue to gravitate to the Tampa Bay area and to a lesser degree in Fort Myers. Under current (1980) conditions, it is unlikely that other cities will have much industrial development in the next decade or two.

Industries often locate in floodplains, but their attempts to do so usually lead to serious conflicts. According to the Urban Land Institute, "Historically, industrial development followed the course of railroads along the river valleys. Because most of these rail lines are being used and interest in the availability of multimodel transportation is increasing, flood plains remain attractive to the industrial development" (Lochmoeller 1975). This is true in Southwest Florida, and the problem may get worse because of the threat of flooding from hurricane surge and excessive rainfall.

Another major conflict is the concentration of industrial development along the coast. Much of the land for urban, suburban, and industrial development is low and subject to tidal surge; consequently, plans for further development of coastal lands should be carefully reviewed. The competition for suitable land for any kind of development is intense, and less expensive, but marginally preferred lands (often valuable marshes that are filled in) sometimes are in demand.

Other problems for locating industrial sites are the potential exhaustion of freshwater supplies in some areas and the intrusion of saltwater into groundwater supplies along the coast. Continued pumping, particularly increased pumping of groundwater to keep pace with new freshwater demands, could cause severe saltwater intrusion in some areas.

A recently recognized problem is the potential seepage of toxic wastes from surface impoundments into groundwater. This is of particular concern in areas where chemicals are manufactured. This issue was highlighted in a nationwide study on surface impoundment assessments by a congressional committee in 1980 (Florida Department of Environmental Regulation 1980). Based on the probability of deterioration of a retaining structure or lagoon containing toxic or hazardous waste, about 50 sites in Florida have been identified as having a potential for polluting drinking water. Most of these sites are in the Miami-Fort Lauderdale area; only five are in Southwest Florida. As industry expands around Tampa Bay, especially chemical manufacturing, the number of storage sites that contain potential hazards to drinking water also will increase.

It is clear that some urban centers of Southwest Florida are likely to undergo further industrial expansion. Much of the expansion may locate in valuable natural environments unless local controls or permit restrictions prevent it.

DATA GAPS

The lack of recent data, especially that to be compiled by the U.S. Government population census for 1980, makes it difficult to give a perspective or status report on current conditions relating to residential and industrial development in Southwest Florida. This chapter should be updated when this information becomes available to verify the interpretation of trends and to make comparisons with other 1980 census information.

PUBLIC UTILITIES

Residential and industrial development are in part dependent on the availability and capacity of public utilities. Since OCS oil and gas recovery would place new demands on public utilities, it is important to understand the type, distribution, and degree of services available in Southwest Florida.

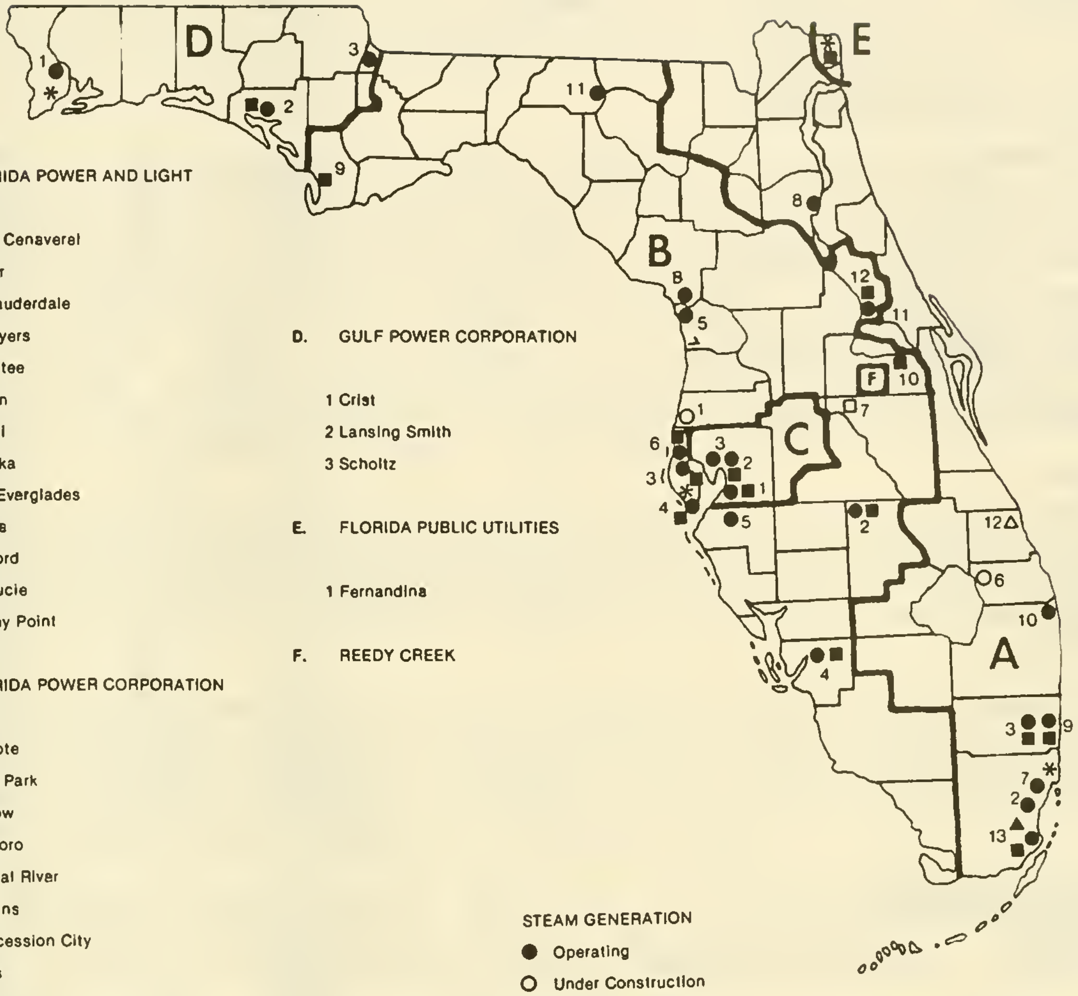
INVENTORY OF UTILITIES

Generation of electrical power in Florida depends heavily on imported fuel oil. A number of generating facilities are now being converted to burn a combination of oil and pulverized coal. Although these conversions are expensive, coal should replace oil as the primary source of fuel in Florida sometime before 1990.

Of the four privately-owned utilities in the State, the three that serve the ten-county Southwest Florida region are Florida Power and Light (headquartered in Miami), Florida Power Corporation (St. Petersburg), and Tampa Electric Company (Tampa). The service areas of these three utilities are shown in Figure 2.

The Florida Power and Light Company (FLPL), with plants in 11 locations (and two more plants under construction), has the largest new capability of any power utility in the State. Its service area covers virtually all of southern Florida and extends along the east coast as far north as Jacksonville. It serves seven of the ten counties in Southwest Florida (Charlotte, Collier, DeSoto, Lee, Manatee, Monroe, and Sarasota), but only 2 of its 11 plants are in Southwest Florida. the Fort Myers facility in Lee County has two fossil fuel steam generating units operating on heavy oil, and 12 combustion turbine generating units operating on light oil (Table 16). The Manatee facility in Manatee County has two fossil fuel steam units that use heavy oil.

The Florida Power Corporation, which has the second largest power capability in the State, serves Pinellas and Pasco Counties, as well as much of central and northwestern Florida. In Pinellas County, FLPC operates the Anclote facility at Tarpon Springs, which has two fossil steam units operating on heavy oil, the Bartow plant in St. Petersburg, which has three fossil steam units fueled by heavy oil, and four combustion turbine units fueled by light oil. The Higgins plant at Oldsmar has three fossil fuel units fueled by heavy oil and four combustion turbine units operating on light oil (Table 16).



A. FLORIDA POWER AND LIGHT

1 Cape Cenaverel
2 Cutler
3 Ft. Lauderdale
4 Ft. Myers
5 Manatee
6 Martin
7 Miami
8 Palatka
9 Port Everglades
10 Rivera
11 Sanford
12 St. Lucie
13 Turkey Point

B. FLORIDA POWER CORPORATION

1 Anclote
2 Avon Park
3 Bartow
4 Bayboro
5 Crystal River
6 Higgins
7 Intercession City
8 Inglis
9 Port St. Joe
10 Rio Pinar
11 Suwannee River
12 Turner

C. TAMPA ELECTRIC COMPANY

1 Big Bend
2 Gannon
3 Hookers Point

D. GULF POWER CORPORATION

1 Crist
2 Lansing Smith
3 Scholtz

E. FLORIDA PUBLIC UTILITIES

1 Fernandina

F. REEDY CREEK

STEAM GENERATION
● Operating
○ Under Construction
NUCLEAR GENERATION
▲ Operating
△ Under Construction
INTERNAL COMBUSTION OR GAS TURBINE
■ Operating
□ Under Construction
* IOU HEADQUARTERS

Figure 2. Location of privately owned electric facilities, and type of power generation in Florida (Florida Public Service Commission 1979).

Table 16. Electrical generating facilities in Southwest Florida in January 1980 (Florida Electric Power Coordinating Group 1980).

Company and plant	County	Number of units	Unit[a] type	Fuel[b]	In service
Florida Power and Light Co.					
Fort Myers	Lee	1	FS	HO	1955
		2	FS	HO	1969
		1-12	CT	LO	1974
Manatee	Manatee	1	FS	HO	1976
		2	FS	HO	1977
Florida Power and Light Corp.					
Anclote	Pinellas	1	FS	HO	1974
		2	FS	HO	1978
Bartow		1	FS	HO	1958
		2	FS	HO	1961
		3	FS	HO	1963
		1-4	CT	LO	1972
		1-4	CT	LO	1974
Higgins		1	FS	HO	1951
		2	FS	HO	1953
		3	FS	HO	1954
		1	CT	LO	1969
		2	CT	LO	1969
		3	CT	LO	1971
		4	CT	LO	1971
Tampa Electric Co.					
Big Bend	Hillsborough	1	FS	C	1970
		2	FS	C	1973
		3	FS	C	1976
		1	CT	LO	1969
		2-3	CT	LO	1974
Gannon		1	FS	HO	1957
		2	FS	HO	1958
		3	FS	HO	1960
		4	FS	HO	1963
		5	FS	C	1965
		6	FS	C	1967
Hookers Point		1	CT	LO	1969
		1	FS	HO	1948
		2	FS	HO	1950
		3	FS	HO	1950
		4	FS	HO	1955
		5	FS	HO	1955

[a] FS = Fossil steam, CT = Combustion turbine

b HO = Heavy oil, LO = Light oil, C = Coal

The Tampa Electric Company serves Hillsborough County and the immediate areas east and northeast. The Big Bend plant, which is one of the three plants located in Hillsborough County, has three fossil steam units and three light oil combustion turbine units (Table 16). The Gannon facility has four heavy oil steam units, two coal steam units, and one light oil combusion turbine unit. The Hookers Point facility has five heavy oil steam units.

The only publicly-owned electric utility in Southwest Florida is a nongenerating utility at Key West.

Four rural nongenerating electric cooperatives serve portions of Southwest Florida. The Withlacoochee River Electric Cooperative, located in Dade City (Pasco County), covers Pasco County, Pinellas County, and part of Hillsborough County. The Peace River Electric Cooperative, headquartered in Wauchula (located outside the region), distributes electricity to Sarasota County, Manatee County, and the remainder of Hillsborough County. The Lee County Electric Cooperative, located in North Fort Myers, has a divided service area. It supplies parts of Lee County, part of Charlotte County, and most of Collier County. Most of the eastern Keys are serviced by the Florida Keys Electric Cooperative, located in Tavernier.

The electric utility companies serving Southwest Florida operate within a broad interstate network. Few areas in Florida are self-sufficient in electrical power, and the network ensures power during all levels of demand. Information about major interconnections for bulk power transactions is given in Table 17.

In Florida, fuel types and their percent contribution for power generation are fuel oil - 48%, coal - 19.5%, nuclear - 16.4%, natural gas - 16.1%, and an insignificant amount of hydropower. All of the oil and coal used in Florida for energy generation is imported from other places, except for a relatively small amount produced in Northwest Florida.

The percent consumption of electricity by different consumers reported for Florida in 1980 shows that most of the power was used by residential users, followed by commercial and industrial users, in that order (Table 18).

Net generation of power for Florida in 1979 was about three times greater than it was in 1965 (Table 19). The percentages of generation by fuel type have changed considerably. The biggest change was in nuclear fuel. None was used in 1972 but by 1980, it contributed 16% of the State total. Fuel oil is the major fuel type, but its contribution declined from 52% in 1965 to 45% in 1979. The greatest increase in the use of coal as a fuel was in 1978-79, an increase that is likely to persist through the 1980's. More than twice as much power was generated by gas in 1979 than in 1965, but its contribution to total power declined from 25% to 16%. Hydro-electric power plants contribute little to the electric energy supply.

In general, the private utility companies serving Southwest Florida have a different pattern of distribution for users than do the electrical cooperatives. Private utilities largely serve the commercial and industrial areas, whereas most cooperatives serve residential areas.

Table 17. Bulk power network in Southwest Florida in 1978 (Federal Energy Regulatory Commission 1981).

Name	Code	Network utilities[a]	Power sources[a]
Investor-owned systems:			
Florida Power & Light Co.	FLPL	FLPL, FTPA, HOME, JACO, LAWU, NEWB, ORLA, TAEC, VEBM	
Florida Power Corp.	FLPC	FLPL, GAMW, GEPC, GUPC, KISS, LALW, TAEC, TALL	
Tampa Electric Co.	TAEC	FLPC, FLPL, LALW	
Municipal systems:			
Key West Utility Bd.	KEWU	U.S. Naval Air Station	
Rural electric Coop:			
Florida Keys Electric Corp.	FLKE		FLPC, SEPA, SIME
Lee County Electric Co-op.			FLPC, SIME
Peace River Electric Co-op.			FLPC, FLPL, TAEC
Withlacoochee River Electric Co-op.			FLPC, SIME

[a]FTPA - Fort Pierce Utility Authority; GAMW - Gainesville/Alachua Regulatory Utility Board; GEPC - Georgia Electric Power Co.; GUPC - Gulf Power Co., HOME - Homestead Municipal Lake Worth Utility Commission; NESB - New Smyrna Beach Utility Commission; ORLA - Orlando Utility Commission; SEBU - Sebring Utility Commission; SEPA - Southeastern Power Administration; SIME - Seminole Electric Co-op.; TALL - Tallahassee Electric Co.; VEBM - Vero Beach Municipal Utility.

Table 18. Percent of megawatt hours of electric power used by different consumers of power companies serving Southwest Florida (Florida Public Service Commission 1980).

Power Company	Consumer			
	Residential	Commercial	Industrial	Other
FL Power & Light Co.	53.4	36.5	8.0	2.1
FL Power Corp.	47.7	25.1	22.1	5.1
Tampa Electric Co.	32.8	20.5	40.5	6.2
FL Keys Electric Co.	49.2	22.8	27.2	0.8
Lee County Electric Co.	65.3	34.3	-0-	0.3
Peace River Electric Co.	74.5	11.2	6.6	7.7

Table 19. Net generation (million kw/hours) by fuel type in Florida from 1965 to 1979 (Florida Public Service Commission 1980).

Year	Coal	Fuel oil	Gas	Nuclear	Hydro	Total
1965[a]	5,399	17,019	7,556	--	298	30,273
1966	7,017	18,634	8,463	--	290	34,404
1967	9,534	18,965	9,391	--	286	38,176
1968	10,156	20,118	13,239	--	242	43,755
1969	10,199	21,962	16,405	--	273	48,940
1970	11,394	25,829	17,954	--	292	55,469
1971[b]	11,184	31,822	17,403	--	253	60,662
1972	11,631	40,439	15,032	66	238	67,407
1973[c]	14,625	42,313	14,602	4,681	231	76,452
1974[d]	13,880	39,549	13,861	7,297	249	74,836
1975	12,592	44,045	12,586	8,370	232	77,825
1976	13,500	47,238	11,315	8,648	256	80,957
1977	15,118	41,454	12,452	17,536	239	86,803
1978	15,747	45,954	14,366	15,366	224	91,514
1979	18,301	45,034	14,112	15,396	247	94,090

[a] 1965-70 Edison Electric Institute.
[b] 1971-72 Federal Power Commission.
[c] 1973 FPC Form 23, Electric Utility Companies.
[d] 1974-79 FPC Form 4.

The Ten-Year Plan

The 1980 "Ten-Year Plan" for Florida, prepared by the Florida Electric Power Coordinating Group (1980), projects an annual statewide rural and residental user increase (in megawatt hours) of 3.8% annually through the 1980's (down from an annual increase of 6.4% in the 1970's), and an annual increase of 3.6% for industrial users (down from 5.1%). Rapid residential growth in Southwest Florida may result in a somewhat larger percent annual increase in residential use of energy than for the State as a whole. Overall, the average annual growth rate for the State in the 1970's was 6.5%, but it is expected to fall to 4.3% in the 1980's.

The amount of fuel oil used in Florida in the 1980's will decline from about 54% to 34%, and the amount of coal will increase from 17% to 47% (Florida Electric Power Coordinating Group 1980). The contribution of natural gas is expected to decrease from 16% of the generated energy in 1979 to only about 1% at the end of the decade. Because only one additional nuclear fueled generating unit (Saint Lucie) is expected to be in service in the 1980's, the percent contribution of nuclear energy to the State total is expected to decrease (Florida Electric Power Coordinating Group 1980).

Eight of the nine proposed additions to or changes in steam-powered generating facilities in Southwest Florida in the 1980's will use coal as fuel. The only light oil unit, a combination turbine generating unit, will be put in service by the Florida Power Corporation in 1989. Three of the new units will be located in Hillsborough County and one will be in Pinellas County. The locations of the other five units have not yet been designated.

The Florida "Ten-Year Plan" for electrical power generation and distribution forecasts a capability to meet all needs for Florida and Southwest Florida. This capability is based on a complex network of intrastate and interstate transfers. This projection is almost totally dependent on the shipment of coal and oil from out-of-state sources.

Telephone

Three telephone companies serve Southwest Florida. The Southern Bell Telephone and Telegraph Company (located in Miami) is the largest; it has 100 exchanges and 10% of the main stations and trucks (Florida Public Service Commission 1981). The General Telephone Company of Florida (headquartered in Tampa) is second largest; in 1980, it had 24 exchanges and 24% of the number of main stations and trunks in the State. Southern Bell serves Monroe County with exchanges at Key Largo, Key West, and Marathon.

Of the 24 exchanges operated by the General Telephone Company of Florida, 18 are located in Southwest Florida (Florida Public Service Commission 1981). Six are in Hillsborough County (Plant City, Tampa-central, Tampa-east, Tampa-north, Tampa-south, and Tampa-west), two in Manatee County (Bradenton and Palmetto), two in Pasco County (Hudson and Zephyrhills), three in Pinellas County (Clearwater, St. Petersburg, and Tarpon Springs), and five in Sarasota County (Englewood, Myakka, North Port, Sarasota, and Venice).

The other two telephone companies serving Southwest Florida are the Florida Telephone Corporation and the United Telephone Company of Florida, both

headquartered in Altamonte Springs (Florida Public Service Commission 1981). The Florida Telephone Corporation has 34 exchanges, but only two of these are in Southwest Florida (Dade City and San Antonio, in Pasco County). The United Telephone Company has 30 exchanges. Of the 18 in Southwest Florida, three are in Charlotte County (Cape Haze, Port Charlotte, and Punta Gorda), five are in Collier County (Everglades, Immokalee, Marco Island, Naples, and North Naples), one is in DeSoto County (Arcadia), and nine are in Lee County (Boca Grande, Bonita Springs, Cape Coral, Fort Myers, Fort Myers Beach, Lehigh Acres, North Fort Myers, Pine Island, and Sanibel-Captiva Islands).

POTENTIAL ONSHORE IMPACTS OF OCS OIL AND GAS EXPLORATION AND PRODUCTION

No oil or gas is produced off the west coast of Florida, but a large discovery would have a major effect on onshore industrial and commercial development. During intense exploration, the influx of workers could cause competition for existing residential units and industrial sites. If production started, new residential construction probably would begin to meet the housing needs of OCS related workers. In addition, some of the manufacturing industries in the area probably would redirect their production to meet the needs of offshore oil and gas operations. Other industries would likely convert their operations to meet the new demands and a number of new support industries might locate in the principal community or communities serving the offshore operations. At worst, these developments could place a considerable strain on the community and on public services, and cause degradation of the natural environment. Recognizing this, Hoedecker stated that "potential environmental hazards of onshore development are greater than those of offshore development," and former Florida Attorney General Robert Shevin once recommended "that before offshore oil drilling was approved, tough restriction be placed on onshore development" (Hoedecker 1980). Only a few communities in Southwest Florida would have much new onshore development. Inland and coastal communities with inadequate harbors and channels (less than 18 to 25 ft deep) and inadequate dock space would be little affected (Calder 1978).

The five-phase sequence of the development of offshore oil and gas, if it occurs, is (1) preliminary geophysical and geological surveys, (2) exploratory drilling, (3) development, (4) production, and (5) decline (Calder 1978). Geophysical surveys require few onshore support facilities, but exploratory drilling usually requires adequate docking space and harbors. If exploratory operations are on a large scale, suppliers of shore services and drilling-related equipment will locate in the port area and subsidiary businesses are likely to spring up. OCS oil and gas companies often choose to locate in smaller communities because of the high cost of land in urban areas.

After discovery, oil and gas development could cause severe stress on the socioeconomic and natural environments (Calder 1978). The population increase could cause housing shortages and transportation, school, and hospital services would be strained. In the process, some valuable natural resources would be threatened.

Care must be taken during the developmental phase to avoid overcommitting public facilities and services. After wells have become producing wells, the need for labor, facilities, and services would decline rather sharply. With

this in view, the following advance planning for offshore community development would be helpful, according to Myhra (1980):

Recognize that socioeconomic problems may occur and be willing to do whatever it takes to hold them at a minimum.

Create an impact mitigation task force, group or team.

Develop an impact management plan.

Inventory existing socioeconomic conditions at the site area.

Determine the estimated influx of new workers and their dependents.

Forecast the likely socioeconomic changes on the community.

Translate those adverse impacts into new fiscal deficits.

Provide appropriate funding and financing to mitigate the impacts.

Monitor how well the impact management program is working out.

Redirect the allocation of impact assistance where needed the most.

Continue readjustment activities as long as necessary after construction is complete.

Implementing these procedures (which were initially worked out for nuclear power plant construction site communities) would enable a community to strengthen what is considered as "one of the weakest links in the energy facility construction chain" (Myhra 1980). This would allow a community to mitigate many of the negative characteristics of "boomtown" development and take full advantage of the positive features that such growth can bring.

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SOCIOECONOMIC TRENDS IN AGRICULTURE

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AGRICULTURE IN FLORIDA - AN OVERVIEW

Agriculture in Florida has traditionally been a major source of income and employment. Employment in forest and agricultural production and agricultural support services, such as machinery sales and service, has risen from about 91,646 employees in 1963 to 127,589 in 1978. From 1954 to 1978, real agricultural income (1967 dollars) rose 145% ($769.0 million to $1.9 billion). Farm income includes cash receipts, government payments, non-money income, and other farm income.

The warm climate and abundant rainfall has given Florida farmers an advantage over many other states. The area of Florida is about 37.5 million acres of which 3.1 million acres are rivers, lakes, and other water areas. The land area available for farm, industrial, and urban use is about 34.4 million acres. In 1978, there were 13.4 million acres of farm land and 15.5 million acres of forests. The two together make up about 84% of Florida's land area.

PRODUCTION TRENDS

In 1978 Florida ranked 11th (Table 1) in the Nation in terms of cash receipts ($3.2 billion) from agricultural products (Greene et al. 1980). Cash receipts is income from the sale of agricultural products by the farmer to wholesalers and retailers. Excluding livestock production, Florida in 1978 ranked fifth nationally with total cash receipts of $2.4 billion (Greene et al. 1980). Prior to 1976, Florida's six major agricultural products were (1) oranges, (2) cattle and calves, (3) dairy products, (4) tomatoes, (5) grapefruit, and (6) forest products. After 1975, sugarcane surpassed grapefruit in value of cash receipts. A more precise classification of agricultural products is given in Table 2. Farm products are composed of field crops (vegetables, fruits, and nuts), greenhouse and nursery products, and livestock and forest products (Table 2). Unless otherwise stated, the term agriculture or forest products does not include commercial forestry.

Cash receipts from farm products grown in Florida have increased substantially since the mid-1950's. Receipts in 1979 were about $3.9 billion in current (1978) dollars or $1.8 billion in real dollars (1967 = 100). The retail value of all agricultural and forest products was about $10.9 billion in 1979 according to the University of Florida (Economic data for Florida

Agriculture 1975-80). Crops are by far the most important farm income, comprising 50.4% ($5.5 billion) of the total retail value. Forest products contributed 27.5% ($3.0 billion) of the total retail value of farm products, livestock products contributed 14.1%, and farm products (e.g., turf, alligators, catfish) contributed 8%. This pattern of product composition has remained relatively unchanged over the last two decades. The retail value of the major farm products are given in Table 3.

Prior to 1970, a large percentage of Florida products such as livestock, grains, and milk has gone to local consumption and Florida has been a net importer of many types of produce. Citrus has long been an export crop for Florida, but in 1975-79 the State began exporting other agricultural products, which have grown steadily and will continue to be an important part of Florida's economic base. Total agricultural exports to foreign countries excluding forest products at the wholesale level were approximately $529 million in current dollars in 1979, up $245.4 million since 1975. Fruit and related products have been the major export product constituting 52.8% ($279.4 million) of 1979 total foreign exports. Citrus and processed citrus products, predominantly frozen orange juice concentrate (FOJC), make up the bulk of interstate and foreign fruit exports. In order of sales, the other foreign farm exports

Table 1. Cash receipts (millions of dollars) and national ranking in parentheses of Florida's major agricultural products in 1978 (Institute for Food and Agricultural Sciences 1980).

Field crops	Oranges	Cattle and calves	Greenhouse products	Dairy products	Tomatoes	Florida Total
2,383 (5)	908 (1)	358 (25)	271 (2)	247 (12)	189 (2)	3,239 (11)

Table 2. Agricultural, livestock, and forest product classification for Florida (Addison 1981).

Vegetables	Field crops	Fruits and nuts	Greenhouse	Livestock	Forest
Tomatoes	Sugar cane	Oranges	Chrysanthemums	Cattle and calves	Pulp wood
Sweetcorn	Corn	Grapefruit	Gladiolus	Dairy	Sawlogs
Potatoes	Soybeans	Temples	Gypsophilia	Swine	Veneer
Peppers	Peanuts	Limes	Statice	Eggs	
Watermelons	Tobacco	Tangerines	Orchids	Poultry	
Cabbage	Cotton	Avocados		Honey	
Snap beans		Pecans		Horses	

Table 3. Retail value ($) of Florida agricultural and forest products (in thousands of current dollars) in 1975 and 1978 (Institute of Food and Agricultural Sciences 1980).

Product	1975	1978
Crops		
Fruits and nuts	1,985,248	2,012,968
Vegetables	1,327,684	--
Field crops	1,265,881	--
Nursery	556,350	677,808
Total crops	5,135,163	6,319,416[a]
Livestock		
Meat animals	388,955	745,006
Dairy	395,947	411,528
Poultry and eggs	270,278	317,169
Other	126,198	56,653
Total livestock	1,181,378	1,530,356
Other agriculture[b]	851,070	859,941
Forest products	1,714,285	3,000,000
Total retail value	8,881,896	11,709,713

[a] Includes value of vegetables and field crops.
[b] Includes government payments, horses, game birds, alligators, catfish, and others.
-- Data not immediately available.

are vegetables ($67.8 million), soybeans and related products ($39.3 million), tobacco ($17.6 million), and feed grains ($16.4 million). A comparison of foreign agricultural exports for Florida and the United States for 1975 and 1979 are given in Table 4. Florida alone accounts for 26.8% of U.S. fruit exports. In 1975-79 the real value of Florida's foreign exports grew 38.1%, whereas U.S. exports grew only 14.0%. Florida is currently exporting about 13.6% of the value of it's total agricultural products to foreign markets, and the amount is steadily growing. Agriculture exports account for 11.8% of Florida's foreign exports.

In 1954-78, production of Florida agricultural products increased substantially. For example, tomato production increased 237%; oranges, 91%; milk, 144%; and cattle and calves, 35%. The percentage changes of the State's major agricultural commodities in 1954-78 are given in Table 5.

Table 4. United States and Florida agricultural exports in millions of current dollars for fiscal years 1975 and 1979 (Greene et al. 1980).

Commodity	1975 U.S.	1975 Florida	1979 U.S.	1979 Florida
Livestock products				
Meat animals	381.9	3.2	844.1	9.5
Dairy products	143.0	0.6	116.1	0.4
Poultry and eggs	112.0	2.6	368.1	9.9
Hides and skins	393.3	3.9	1,302.7	14.0
Lard and tallow	400.6	5.2	704.8	9.9
Crops				
Wheat	5,236.8	0.7	4,862.0	0.3
Feedgrains	4,858.3	14.6	7,026.1	16.4
Cotton	1,054.5	0.4	1,900.0	0.7
Cottonseed oil	213.5	0.1	197.5	0.1
Tobacco	897.3	20.3	1,292.2	17.6
Soybeans and products	3,376.0	21.0	7,515.0	39.3
Peanuts and oil	166.2	7.2	284.8	13.2
Vegetables and preparations	533.9	34.8	756.2	67.8
Fruits and preparations	674.6	141.3	1,042.4	279.4
Nuts and preparations	151.6	0.4	327.0	0.9
Other agriculture and fisheries				
Greenhouse and nursery	16.6	1.2	9.2[a]	0.9[a]
Fishery products	319.8	5.0	520.5[a]	14.0[a]
Other	1,632.9	21.1	2,550.6	35.1
Total	20,562.8	283.6	31,619.3	529.4

[a]Figures for 1978.

Florida's crops and livestock are produced by 35,100 farms and ranches plus a large network of support industries such as transportation, marketing, processing, and supply. Farms and ranches range from traditional small family or individually-owned operations to a few large-scale multimillion dollar corporate farms. According to the 1978 Census of Agriculture, individual or family farms made up 83% of total farms as opposed to 6.3% for corporate farms. This pattern has remained relatively stable over the last decade. Wilcox et al. (1974) concluded that large corporate farms are not displacing the private individual or family farms. They contend that many of the corporate farms are owned and operated by families and individuals and still exhibit the characteristics of family farms.

The "real" cash value of Florida's agriculture refers to trends which have been adjusted for overall inflation in the economy. Production has expanded (Table 5), real prices have fallen, and the real value of production has increased. Although the increase in farm prices did not keep pace with inflation, the expansion in production offset the declining real prices resulting in a rise in the real value of agricultural production. The strong demand for Florida's agricultural products coupled with rising productivity has increased employment in Florida. Although production has increased, the number of farms and farmland has declined. A detailed analysis of this change is reported later in this report. The number of farms from 1954 to 1979 decreased from 57,543 to 35,100 (39%), and the land area in farms declined from 18.1 million acres to 13.4 million acres (26%). These acreages include cropland, pasture, woodland, and other noncultivated land. In 1954-78, the area of cropland increased 32.9%, whereas the area of pasture and woodlands fell 69.4% (Table 6). Acreage in crops has fallen for corn, cotton, eggplant, oats, peanuts, strawberries, tobacco, tomatoes and others, and has increased for celery, sweetcorn, escarole, green peppers, and lettuce. The decline in agricultural land area in Florida can best be explained by considering other factors of production such as capital, labor, fertilizer, and energy. The increased demand for land was brought about primarily by the great increase in population and its attendant needs, which has raised the opportunity cost of holding land. Opportunity cost is value of the best potential rent or revenue foregone by not renting or selling farmland. Because the price of land has risen faster than wages and the cost of capital, farms used less land and more labor and capital. For example, in 1975-79 land and building prices rose 53.6%, machinery prices rose 46.6%, and wages rose 38% (for the trend in these prices see Table 10).

Table 5. Percentage change of agricultural commodity production from 1954 to 1978 (Florida Crop and Livestock Reporting Service. Annual field and crop summaries 1967-78, and Vegetable summaries, 1954, 1960-80).

Commodity	Percentage decrease	Commodity	Percentage increase
Potatoes	3	Soybeans	2,658
Celery	12	Sugarcane	650
Hogs	16	Peanuts	260
Oats	18	Tomatoes	237
Tobacco	20	Corn (grain and feed)	227
Snap beans	50	Milk	144
Cotton	84	Sweetcorn	141
		Green peppers	109
		Oranges	91

Table 6. The number of farms and the area (thousands of acres)[a] of farm lands and use in intermittent years, 1954-78 (U.S. Department of Commerce, Bureau of Census, Census of Agriculture annual summaries for 1954-79; Florida Crop and Livestock Reporting Service. Annual field and crop summary 1979).

Year	Number of farms	Area			
		Land in farms	Cropland	Pasture and woodland	Other land use
1954	57,543	18,162	3,398	9,853	4,910
1959	45,100	15,237	3,401	7,672	4,164
1964	40,542	15,412	3,581	7,257	4,573
1969	35,586	14,032	3,774	4,817	5,441
1974	32,466	13,199	3,722	4,019	5,459
1978	35,100[b]	13,435	4,519	3,015	5,901

[a] Not fully comparable for all years because of differences in definition of a farm and of cropland used for pasture.

[b] Data for 1979.

The introduction of new machinery has made the cultivation of large farms more efficient and less costly per acre than smaller farms. Consequently, many small farms are absorbed as the demand for large-scale operations increases. This trend explains why the average acreage per farm steadily increased in 1954-78. Many of the innovations that have contributed to the phenomenal growth in farm production and farming methods have aroused public concern; the increase in the application of chemicals, fertilizers, and pesticides have caused water pollution in some areas of Florida. This topic will be discussed in detail later in this report.

The increase in farming technology in recent years in the United States has caused a decline in farm employment (Greene et al. 1980). Florida is an exception. Employment in agriculture has increased because many of Florida's crops can not yet be cultivated or cropped mechanically. Any increase in demand for farm products, such as oranges and grapefruit, creates an increase in the demand for labor and other nonmechanical inputs. The exceptions are the animal industries and some field crops that use mechanization as a substitute for labor.

MAJOR AGRICULTURAL PRODUCTS

Citrus and Other Fruits

Citrus fruits, the State's main agricultural product, accounts for over 30 percent of all farm cash receipts (Greene et al. 1980). Florida is the Nation's largest supplier of oranges and is among the world's largest fruit

producers. Other fruits are grapefruit, lemons, limes, avocados, mangos, peaches, and berries. When compared to citrus fruits, other fruit crops are relatively small and few are exported. Most citrus fruit is not marketed fresh as are other fruits, but is processed into frozen concentrate. In 1954-78 the cash receipts of citrus crops increased sharply, but total acreage fell. Loss of citrus fruit acreage was due primarily to the conversion of land to phosphate mining and urbanization.

Vegetables

Florida excells in other agricultural products and between October and June is the Nation's leading supplier of many fresh vegetables. Their abundance in order of importance are tomatoes, sweetcorn, celery, potatoes, and peppers. The State is ranked second in the Nation in the production of tomatoes. Florida's unique climate permits the growth of both cool weather and warm weather vegetables at the same time.

The percentage growth in vegetable production has matched the growth in the State's population until recently. This was due largely to the conversion of farm acreage to urbanization and a decline in yield per acre. The implication of this trend is that a greater share of vegetable production is consumed locally and less is exported.

Nursery Products

The newest and fastest growing of Florida's agricultural sectors are nursery and ornamental horticulture products such as gladiolus and foliage. In this regard, Florida ranks second in the Nation. In 1978 estimated cash receipts were about $271.1 million in real dollars (1967 = 100), up nearly 18% since 1974. Florida is the world's leading producer of foliage plants, accounting for over 75% of the U.S. production. Much of Florida's cut foliage is exported to florists in Europe and Canada. Florida is second in production among the states for flowering plants, gladiolus, chrysanthemums, sypeophila, poinsettas, orchids, and other similar plants. Florida is the Nation's sole supplier of some of the 300 varieties of plants in this industry (Greene et al. 1980).

Animal Husbandry

Animal husbandry is another major sector of agriculture. Excluding forestry, it is the most land intensive sector and is the fastest changing agricultural industry. Rising land values have spurred research to increase productivity by using new feeds, nutrients, and animal breeds. The value ($358 million) of Florida's cattle and calf production in 1978 was second only to oranges in the State and was ranked 25th in the Nation. The egg and poultry industry's cash receipts were $184.2 million, and dairy products were $247.3 million. According to the Florida Crop and Livestock Reporting Service, annual dairy summaries (1970-80); poultry summaries (1960-80); livestock summaries (1960-80), Florida imports beef, lamb, pork, milk, and poultry to meet its needs, but exports eggs.

Forestry

Forests, the major land use in the State, occupy 15.5 million acres, or 45% of the State's land. In 1978, real cash receipts of forest products were about $61.4 million. Real income increased 18% in 1975-78. Over 50% of Florida's forest land is controlled by non-industrial users (noncorporate owners). The bulk of commercial forests and wood processing and manufacturing plants is located in north and west Florida. Forest products have the largest retail markup of any agricultural products, i.e., 2,500% from the tree to the consumer. Sawlogs and pulpwood are the major products from the State's timber industry.

Although this study is concerned largely with the socioeconomic aspects of agriculture, there are other considerations. Many other jobs, businesses, and other sources of income stem from agriculture. Examples are the feed, fertilizer, and machinery industries that support farming and processing industries, transportation, papermills, services and industries, and others that derive their existence from Florida ranchers and farmers. These subjects are discussed in the following section.

AGRICULTURE IN SOUTHWEST FLORIDA

The coastal region of Southwest Florida is comprised of ten counties with a land area of 5.9 million acres or approximately 15.8% of the State's total land area. According to the Florida Crop and Livestock Reporting Service, Southwest Florida is among the State's principal citrus, vegetable, beef cattle, and egg producing areas. The northern half of the region from Pasco County to Sarasota County is a major producer of tomatoes, peppers, sweetcorn, cabbage, lettuce, celery, bush and pole beans, oranges, beef cattle, dairy cattle, and eggs. This area also supports numerous processing plants and citrus concentrate processing and transportation facilities.

The southern half of Southwest Florida, from Charlotte to Monroe County, is a major producer of sweetcorn, cucumbers, eggplant, peppers, potatoes, tomatoes, and watermelons. In 1978, Southwest Florida contributed 2.1 million acres or 15.9% of the State's agricultural acreage (Florida Statistical Abstract 1980). The land for the most part is low and flat. Drainage is required because swamps and marshes comprise much of the land. The area is almost semitropical; average daily temperatures range from a low 50° to 60°F in the winter to a high of 80° to 90°F during the rainy season (June through September).

The two basic soil types in Southwest Florida are apparent by the diversity of agricultural crops. Pasco and northern Hillsborough Counties have gently sloping hills, sandy soil, and moderately good drainage, whereas, Pinellas, Manatee, and Sarasota have sandy soil and poor drainage. Sandy soil is excellent for citrus fruits and many vegetable crops. Lee, Collier, and Monroe Counties have a serious drainage problem. Much of the soil is peat and muck.

LAND AND CROP CHARACTERISTICS

The climate, soil, and topography make Southwest Florida a major producer of many of Florida's agricultural products. Among the counties, Hillsborough and Manatee Counties rank in the top ten in the State.

The ten counties have considerable potential for further agricultural development. The 2.1 million acres in farm production is only about 50% of the potential land available for farming. According to a Soil Conservation Service estimate in 1977, Florida had 1.4 million acres of prime agricultural land, and 1.2 million acres more suited for citrus and vegetable crops. Prime land is the best suited for field farming. It is generally flat or gently sloping land with good drainage and subject to little or no erosion. Farming on this land is the least costly per acre and consequently exhibits the highest yield. The majority of prime farmland is located in north Florida. Only Pasco and Hillsborough Counties have prime acreage, and it is only 5.2% of the State total.

Unique farmland is land other than prime farmland that is used for the production of specific high-value food and fiber crops. It has the special combination of soil quality, location, growing season, and moisture supply needed to produce sustained high quality and/or high yield of citrus fruit, avocados, mangos, papayas, lettuce, cabbage, radishes, celery, carrots, tomatoes, cucumbers, and potatoes. Except for Monroe County, all counties have unique farmland.

The area of citrus fruit groves among the counties are Hillsborough, 38,263 acres; DeSoto, 33,882 acres; Pasco, 33,367 acres; Manatee, 14,730 acres; Charlotte, 6,100 acres; Collier, 5,975 acres; Lee, 5,384 acres; Pinellas, 3,205 acres, and Sarasota, 1,604 acres. The total is 12.1% of the State's citrus fruit acreage. The nature of the land, especially that which is unique, is important because conflicting uses such as for OCS oil and gas development and residential development may replace some of the fruit crop acreage. Unless productivity of unique lands increases substantially, the prices of products produced there may rise.

FARM NUMBERS, SIZE, AND VALUE

The trend in agriculture is towards fewer and larger farms. The average farm in Southwest Florida is and has been larger than the average Florida farm (Table 7). In 1954, the average area per farm in Southwest Florida was 382 acres whereas the State average was 316 acres. In 1978, the average acreage per farm in Southwest Florida declined 8.8% to 348 acres, and the average size farm in Florida declined 3.6% to 304 acres. In 1954, the 8,677 farms and ranches in Southwest Florida accounted for about 15% of the State's farm land. These farms and ranches covered 3.3 million acres. In 1954-78, the number of farms in Southwest Florida declined from 8,677 to 6,127 (about 30%). In 1978, the area of farm land was about 2.1 million acres, a decline of 35.6% since 1954 (Table 8).

The number of farms (including ranches) and farm acreage has decreased faster in Southwest Florida than in the State as a whole. In 1954, Southwest

Table 7. The number of farms (average acreage in parentheses) in the ten counties of Southwest Florida in 1954, 1959, 1964, 1969, 1974, and 1978 (U.S. Department of Commerce, Bureau of Census, Census of Agriculture, annual summaries 1954-81).

County	1954	1959	1964	1969	1974	1978
Charlotte	148 (2,569)	74 (3,176)	92 (2,978)	153 (1,425)	196 (875)	184 (920)
Collier	116 (3,634)	104 (3,042)	105 (3,042)	116 (2,672)	145 (1,873)	221 (1,432)
DeSoto	505 (914)	385 (764)	428 (764)	562 (483)	677 (414)	495 (633)
Hillsborough	4,492 (192)	3,439 (225)	3,398 (226)	2,769 (153)	2,335 (153)	2,635 (121)
Lee	458 (480)	279 (511)	316 (511)	326 (435)	313 (405)	369 (191)
Manatee	804 (384)	753 (336)	699 (386)	667 (479)	632 (591)	675 (511)
Monroe	11 (44)	17 (53)	16 (38)	4 (2)	7 (1)	13 (6)
Pasco	1,036 (388)	1,012 (306)	1,138 (316)	1,133 (299)	934 (336)	1,044 (294)
Pinellas	758 (75)	546 (104)	446 (109)	290 (74)	211 (73)	236 (74)
Sarasota	349 (564)	325 (510)	261 (649)	190 (786)	208 (1,056)	255 (929)
Counties Combined	8,677 (382)	6,934 (367)	6,899 (384)	6,210 (345)	5,658 (377)	6,127 (348)
Florida	57,543 (316)	45,100 (338)	40,542 (380)	35,586 (394)	32,466 (407)	44,165 (304)

Table 8. Farm acreage (including ranches) in the ten counties of Southwest Florida in 1954, 1959, 1964, 1969, 1974, and 1978 (U.S. Department of Commerce, Bureau of Census, Census of Agriculture, annual summaries for 1954-78).

County	1954	1959	1964	1969	1974	1978
Charlotte	380,283	235,056	273,039	218,007	171,403	169,202
Collier	421,589	316,424	304,469	309,914	271,515	316,532
DeSoto	461,405[a]	294,261	295,660	271,471	280,316	313,158
Hillsborough	863,243[a]	773,468[a]	769,240	374,767	358,178	318,852
Lee	219,932	142,509	161,475	141,959	126,690	107,246
Manatee	309,125	252,812	270,146	319,664	373,669	345,102
Monroe	485	904	601	6	10	77
Pasco	402,395	309,807	359,975	338,319	313,828	307,425
Pinellas	56,955	57,052	48,447	21,347	15,439	17,464
Sarasota	196,785	165,648	169,300	149,373	219,613	236,774
Counties Combined	3,312,197	2,547,941	2,652,352	2,144,827	2,130,661	2,131,832
Florida	18,169,377	15,236,521	15,411,181	14,031,998	13,199,365	13,434,730

[a]Data is based on county location of farm headquarters and may include acreage from adjoining counties.

Florida contributed 15% of the farms and 18% of the land in farms in Florida, but in 1978, it contributed only 7% and 15.9%. In 1954-78, Charlotte, Collier, Monroe, and Pasco Counties reported increases in the number of farms, and only Manatee and Sarasota Counties reported an increase in farm acreage. The decline in the number of farms between 1954 and 1978 can be attributed to a change in the definition of a farm and economic factors. Since 1974, the Bureau of the Census has defined a farm as any place with sales of at least $1,000 in agricultural products in the previous year. Before 1974 a farm was defined as any place of 10 acres or more with sales of at least $50 the previous year, or any place of less than 10 acres with at least $250 of sales in the previous year. These differences make it difficult to compare the number and area of farmlands before and after 1974, but the trends are still distinguishable. Economic factors such as the rising cost of production and farm size are discussed later in this report.

For socioeconomic purposes, the composition of annual farm sales or sale receipts is highly useful (Table 9). Although the acreages of the State and Southwest Florida are widely different, the percentage of farms in the same category are remarkably similar. Nationally the smallest class of farms (farms reporting less than $2,500 in annual sales) decreased in number by 28% from 1954 to 1978.

In Southwest Florida, only Manatee and Sarasota Counties reported increases in the average acreage per farm in 1954-78, but in 1974-78, six of the counties reported increases in average acreage. Another meaningful socioeconomic measure of agriculture is the annual sales of farms. The distribution of farm sales for the region and State are given in Table 9. In 1974, 60% of the farms had farm sales exceeding $2,500, but in 1978, the percentage increased to 70% (U.S. Department of Commerce Bureau of Census, 1954-81).

In 1954-78, when the number of farms and farm acreage were falling, the value of the farms (land and buildings) increased. In current dollars, the 1978 value of Southwest Florida farms was $2.5 billion which was 16% of the

Table 9. Number of farms and percent (in parentheses) of farm sales in different income categories in Southwest Florida in 1978 (adapted from preliminary data of the U.S. Department of Commerce, Bureau of Census 1981).

Area or State	Under $2,000	$2,000 to $2,499	$2,500 to $4,999
Southwest Florida	6,127 (69)	1,843 (30)	897 (15)
Florida Total	49,165 (73)	15,956 (36)	6,262 (14)
	$5,000 to $9,999	$10,000 to $19,999	$20,000
Southwest Florida	803 (13)	672 (11)	1,912 (31)
Florida Total	5,432 (14)	4,733 (11)	11,782 (25)

State total; in 1969 it was 10%. The real value of farms in Southwest Florida rose about 81% ($717 million in 1969 to $1.3 billion in 1978; 1967 = 100). The value of land is determined, as with most other commodities, by the interaction of supply and demand. Since the supply is relatively fixed in Florida, demand usually determines the price. The demand, or multiple-use conflicts, for land are urbanization, recreation, phosphate mining, industrialization, and agriculture (U.S. Department of Commerce, Bureau of Census annual summaries 1954-81).

Land to the farmer is a capital asset that provides an annual income. It draws its value from the prospect of cultivation and future sale. The value of a farm is equal to the Net Present Value (NPV) of the future earnings from cultivation. To the nonfarm user, land value is drawn from the development potential, natural beauty, proximity to retail, commercial or service focal points, and mineral deposits, to mention a few. The value to these users is the net present value of the future earnings from farm and mineral products.

If for any reason the costs are lowered or demand for the produce increases, then the net present value increases. Population increases raise the demand for land for both farm and nonfarm use; however, on urban fringes the demand for nonfarm use of the land is usually greater. The value of land to nonfarm users has risen more than the land of farm users, and the price of land has risen as nonfarm users compete to purchase available land. At this point the farmer would sell his land if the revenue from the sale exceeds the net present value of further cultivation.

For examining the economics of farming, a generalized farm production function is used: $Q = f(L, K, T, C, E)$ where the quantity of output (Q) is a function of the inputs labor (L), capital (K), land (T), chemical and fertilizers (C), and energy (E). There are many combinations of inputs which yield a given level of output. The farmer usually will use the least-cost combination of inputs that yields a given level of output. The farmer also will adjust the combination of inputs as their costs change or as the productivity (technological change) of output changes (e.g., qualitatively more efficient capital).

In Southwest Florida, the population has been growing faster than the State average, and the demand for nonfarm land use has increased. As the population increases, there is need for more housing, recreation facilities, and retail and commercial establishments. This not only raises the land value but also the farmer's opportunity cost of holding land. The farmer will seek to substitute other inputs as specified in the generalized farm production function for land to maintain a least-cost combination of inputs to produce the same level of output. An index of prices paid annually by farmers for selected input in 1975-79 is given in Table 10. Analysis of the data reveal that real land values have increased 53.6%, whereas machinery prices increased 46.6%, wages increased 38%, and the real prices of fertilizers and chemicals declined. Total input prices (excluding land value) rose only 37.2%. This relative increase in the price of land over other inputs accounts for the substitution of inputs such as labor and machinery for land. These results are consistent with the hypothesis that Florida farmers have substituted labor capital and fertilizers for land as the price of land has risen relative to other input prices. Adherence to this procedure has increased the unit productivity of land in Southwest Florida.

The growth of income generated by farming compared to the growth in farm land value is another consideration. Many farms are transferred from older family members to younger members. The income from production is used to pay off the older family members' control of the farm. If the earning power of a farm does not keep pace with the growth of the farm's value over time, it becomes exceedingly more difficult to purchase the farm on a payback basis from farm income. In 1954 the percentage of cash receipts for agricultural products to value of land and buildings was 15.5% in Southwest Florida and 18.0% for all of Florida. In 1978, the percentages were 14.9% and 19.8%. This suggests that it is becoming more difficult for a satisfactory transfer of ownership within families to take place.

The primary influence of the demand for nonfarm use of the land on farm value is controversial. Nonetheless, it is clear that agricultural land is disappearing throughout the Nation, Florida, and Southwest Florida. This pattern is anticipated to continue, and the rate of change in land use may even be accelerated as continued population growth and demand for phosphate increases land values.

FARM INCOME, EXPENSES, AND CONSUMER DEMAND

Historically, farmers have, as an economic group, generally earned less than the average American worker, but this breach is rapidly being closed. For example, in 1970, farm income per person was 25% less than nonfarm income (Wilcox et al. 1974). Farm income is based on cash receipts, government payment, nonmoney income, land rental, and farm services. Florida's gross State farm income has risen steadily since 1954 to $4.1 billion in current dollars in 1979. In 1954-79, Florida's total personal real income grew 454%, but real farm income grew only 145%. The income of individual farmers grew 145%, but the cost of living increased 170%. In short, the American farmer is finding it more and more difficult to make a living at farming. Some are seeking second jobs or receive income from land rental and farm services provided to others. Income from land rental and farm services has helped soften erosion of farm income.

Gross farm income depends on the quantity of output, and farm prices. Farm output has risen, but real prices at the farm level, as opposed to the retail level, have continued to fall, reflecting greater production and profits per acre. Yet any large increase in production brought about by new technology helps lower prices. Farm prices are less stable than farm production costs, and this tends to make net farm income fluctuate greater than gross farm income. The trends in gross and real farm income in 1954-78 are shown in Table 11.

Information on total farm income for Southwest Florida is unavailable. Cash receipts from farm products were about $471 million in current dollars in 1978, up nearly 65% since 1974. The real dollar value of the cash receipts has not risen as rapidly. In 1974-78, real cash receipts have fallen as inflation outpaced earnings. Farmers are better off now than before, but this came about only because the real prices of many farm products have steadily declined.

Table 10. Index number of prices paid by farmers for production items, interest, taxes, and wage rates in the United States for 1975-79 (Greene et al. 1980).

Production items	1975	1976	1977	1978	1979
Feed	187	191	186	183	204
Feeder livestock	134	154	158	221	293
Seed	245	241	261	273	286
Fertilizer	217	285	181	180	196
Agricultural chemicals	60	174	157	147	150
Fuels and energy	177	187	202	211	276
Farm and motor supplies	168	164	165	171	189
Autos and trucks	191	212	234	248	273
Tractors and self-propelled machinery	195	217	238	259	289
Other machinery	197	225	246	266	293
Buildings and fences	206	215	229	248	272
Farm services and cash rent	199	218	235	245	265
Interest	265	303	331	396	501
Taxes	162	176	195	207	221
Farm wage rates	192	210	226	242	265

Table 11. Florida farm income (millions of dollars adjusted to 1967=100) for intermittent years from 1954 to 1978 (Florida Crop and Livestock Reporting Service. Annual summaries 1955 to 1978).

Year	Gross farm income	Real gross farm income	Real farm income[a]
1954	618.6	768.4	303.1
1960	853.7	962.5	362.9
1965	1,064.2	1,124.9	380.6
1970	1,387.9	1,201.9	344.4
1975	2,628.0	1,663.8	600.0
1976	2,637,8	1,547.1	506.9
1977	2,785.5	1,534.7	436.3
1978	3,401.0	1,741.4	677.0
Percentage increase			
1954-78	449.7	123.3	123.3

[a]Net income is gross income minus production, processing, and distribution costs.

Government support payments, another component of farm income, steadily increased from a low of 3.2 million current dollars in 1954 to a high of 20.8 million current dollars in 1977. The real value of government payments peaked in 1964 and have steadily declined since. The original intent of these support payments was to stabilize farm income by providing relief from widely fluctuating commodity prices. Although providing a temporary solution, support payments have, in some cases, aggregated the problem in the long run. For some of the State and regional products, support payments are compensation whenever the farmer sells below a standard price. In essence, an artificial price above the natural market price is maintained which induces area farmers and ranchers to increase production, further lowering the market price, and widening the gap between the natural and artificial price. These payments appear to encourage low unit production.

Another problem is that the aggregate demand for farm products is highly inelastic (i.e., the percentage change in the quantity demanded is always less than the percentage change in price), yet the demand curve confronting the individual farmer is almost perfectly elastic (i.e., the individual farmer can sell all he wants at a given price). The farmer has little control over the price at which he sells, but may sell all he likes at the market price. This encourages the farmer to increase production because it is the only way income may increase when productions costs are high and prices are low. As each farmer strives to increase profits, market supply of farm products increases and prices fall. Given an inelastic aggregate demand for food, a decline in prices lowers total revenue. In the long run, the farmer is caught in a rather vicious circle. The cobweb theorem states that farmers react differently in the short run than in the long run. During lower prices, farmers tend to plant less acres in the year following price cuts. Some producers take even more drastic steps such as slaughtering livestock and destroying crops to reduce supply and increase prices.

In recent years, the real income for State and regional farmers has steadily declined, but retail food prices have increased. Food items in the index prepared by the Survey of Current Business rose 86.8% in 1959-74, but consumer prices rose only about 70%. Much of the inflation in consumer prices can be attributed to rising U.S. retail food prices. Since 1974, rising energy costs have replaced high food prices as the major contributor to inflation. The real prices of tomatoes, eggs, oranges, and milk have fallen since 1974 despite current prices. Real beef prices rose during this period and are still rising. In the case of beef, State and regional farmers are receiving a higher price. In short, the amount of the consumer's income spent on food has risen, but the income received by the farmer has declined.

In view of the price dilemma, farmers should know how consumers react to a change in the price of a commodity or to a change in their income. Price elasticity indicates the percentage change in the quantity demanded by consumers when prices change as little as 1% (Table 12).

Elasticities are for the demand at the retail level. If the price of these commodities increases 1%, the price elasticities of these products indicate that the quantity consumer demand would fall by 0.6196% for beef, 0.0933% for vegetables, 0.6591% for poultry and fish, 0.4134% for fruits, and 0.0679% for eggs (Table 12).

Table 12. Price and income elasticities (percentage change) of major food groups (U.S. Department of Agriculture 1981).

Food group	Price	Income
Meat	0.6196	0.1212
Vegetables	0.0933	0.1816
Poultry, fish	0.6591	0.1682
Fruits	0.4134	0.2613
Eggs	0.0679	0.0625

Should the consumer's real per capita income rise by 1%, then the demand should increase by 0.1212% for meat, 0.1816% for vegetables, 0.1682% for poultry and fish, 0.2613% for fruits, and 0.0625% for eggs. These elasticities, of course, have important implications for retail revenue and pricing strategy.

The effects of income, the trend in real farm product prices, production, and their implication to Southwest Florida and the State are more fully discussed in the following sections. First, they will be discussed as they apply to individual commodities and later as they affect the entire agricultural sector.

Agricultural resource scarcity is tied directly to trends in the real prices of agricultural products. Scarcity can be measured by the trend in real prices of resources according to Barnett and Morse (1963). This trend in real prices measures the interaction of supply and demand.

Agricultural resource scarcity would mean rising real prices at the wholesale level causing a diminishing return from the land. The ultimate burden will be on the consumer if the standard of living declines.

FARM EXPENSES

Real farm expenses currently are growing faster than real farm income. Real total expenses in 1978 for Florida farmers were $1,049 million and are growing at an annual rate of 3.9%, but real farm income is growing 3.2%. The difference is caused by the general decline in real farm prices and the increasing real costs of production.

A decline in prices is preceded by the sale of an additional unit of output (marginal revenue), yet most real costs have been rising. Interest prices rose 89% in 1975-79 followed by increases in energy prices (55%), farm machinery (46.6%), and farm wages (38%). Fertilizers and agricultural chemical costs have fallen 9.6% and 6.2%, respectively.

Pesticides, Fertilizers, and Agricultural Chemicals

The costs of agricultural chemicals, fertilizers, and pesticides generally declined from 1975 to 1979, but since then costs have begun to rise. Only the price of limestone has remained stable. In 1978 in Southwest Florida, farmers spent $12 million real dollars on fertilizer, an increase of 30% since 1954, whereas the State reported an increase of 41%. In 1978, farmers also spent $8.4 million real dollars on other agricultural chemicals.

Vehicles, Machinery, and Energy

In 1975-79, the real cost of vehicles, trucks, cars, tractors, and farm implements increased. Even though the real price of tractors rose about 50%, farmers have increased their use of tractors and other implements. The number of tractors increased by 46% and trucks by 26%. Farmers have increased the use of these inputs because they have substituted them for labor or land. As machinery has become more efficient, it has allowed the farmer to lower his use of land and labor, and because it is more productive, its cost per unit of output is declining.

Real fuel and energy prices have also increased substantially. The current price paid for diesel fuel rose from 10.2 cents per liter in 1975 to 25.3 cents per liter in 1979. In real prices, this was an increase from 6.9 cents to 8.6 cents per liter. Gasoline price increases were similar to that for diesel fuel.

Wages

In 1975-79, the wages of all farm labor increased about 38%. When this is broken down into categories "piece rate" workers received the largest increase (45%) in wages. Farmers have not decreased the use of labor because the high value of land has forced them to substitute labor and capital for land in the production of agricultural products.

To increase profits, most farmers will continue to adjust their use of inputs as their relative prices change up to the point of technical feasibility. They will also continue to use an input until the point where the cost of an additional unit of input equals the revenue from the sale of an additional unit of output. Most farmers will increase the use of fertilizers as long as the cost is less than the revenue.

AGRICULTURAL COMMODITIES

In 1978, Southwest Florida contributed about 16% of the State's cash receipts from the sale of agricultural products. Crops (i.e., vegetables, fruits, and field crops) accounted for 64% of the contribution and 13.7% of the State's total crop sales (excluding forest products). Livestock and poultry products accounted for 36% of the Southwest Florida's total agricultural value and 19% of the State's total animal product sales. The stumpage value of the forest harvest was only $4,170,000 in 1978 current dollars.

The counties ranked by agricultural sales in Southwest Florida are: (1) Hillsborough, (2) Manatee, (3) Pasco, (4) Collier, (5) DeSoto, (6) Lee,

(7) Pinellas, (8) Charlotte, (9) Sarasota, and (10) Monroe. The following section is a detailed discussion of Southwest Florida's five major farm products. A synopsis of their production is given in Table 13.

Table 13. Southwest Florida's five major agricultural products (excluding forest products) and the major producing counties in 1978 (U.S. Department of Commerce, Bureau of the Census 1978; Florida Crop and Livestock Reporting Service 1978).

Commodity	Cash value ($ millions)	Percent of Southwest Florida production	Percent of State production	Major producing county
Oranges	125.9	26.7	19.4	Hillsborough
Tomatoes	121.0	25.6	60.0	Manatee
Milk	61.6	13.1	24.8	Hillsborough
Beef	60.9	12.9	17.0	Hillsborough
Eggs	38.8	8.3	35.5	Hillsborough
Other	63.2	13,4	--	--
Total	471.3	100.0	16.0	Hillsborough

Oranges

Oranges are Southwest Florida's major cash farm product. In 1978, Southwest Florida accounted for 19.4% of the State's orange crop, 6.6% of the State's grapefruit crop, and 16.0% of the State's total citrus crop. Orange production was 23.9 million boxes in 1969 and 31.9 million boxes in 1979. (A box is roughly equivalent to 56 liters or 1-3/5 bushels.) Orange production in the last decade increased 33.4% in Southwest Florida and 26.4% in the State. Hillsborough, Pasco, and DeSoto are the major producing counties. Despite increased orange production, the acreage of orange groves has declined.

Only about 10% of the oranges are marketed fresh either in or out of the State. The remainder is processed into frozen concentrate in Hillsborough, Manatee, and Pasco Counties. The concentrate is transported by rail to Tampa and shipped to interstate markets, Europe, Japan, New Zealand, and Puerto Rico. Orange production provides a sizable income to Southwest Florida's residents in terms of primary production, processing, and distribution. Cash receipts for oranges in 1978 were $125.9 million or about 27% of the agricultural total for Southwest Florida.

As acreage decreased, orange production has increased primarily because of increased application of fertilizers and better weather forecasting. The yield per acre of oranges was 268 boxes in 1954, 290 boxes in 1978, and 350 boxes in 1980.

The current dollar price received by farmers for oranges rose from $1.96 per box in 1960 to $5.00 per box in 1979, an increase of 155%. The real price received by farmers actually fell at an annual rate of 4.3%, whereas retail orange prices fell 2%.

Information about the returns and costs of orange production are available for 1970-79. The real cash value of the region's orange crop increased 172%, whereas production increased 35%. Changes in per acre costs and returns for the average orange farm provides a rise in income. Total real returns per acre have risen 60%, and total real production costs have declined 16%. Real net income (total revenue less total costs) per acre has risen over 75%. All real costs of production have declined and State and local taxes have fallen about 55% because nominal or current dollar taxes have not risen while the costs of most other items have increased.

Changes in real prices over the long run is an index of the abundance or scarcity of oranges (Barnett and Morse 1963). Since the real prices of oranges and concentrates declined, there is no scarcity of oranges. This decline in prices has been brought about by increasing productivity both at the farm and retail level.

Tomatoes

Based on cash receipts, Southwest Florida's second most important cultivated farm product is tomatoes. The value of tomatoes in 1978 was about $121 million in current dollars or $62 million in real dollars (1967 = 100). The production of 17.7 million cartons was 59% of the State's total production. A carton is approximately 33 kg. The production and acreage in 1970 was only about 20% of that for the State. About 9,299 acres were in tomato production, about 55% of the State total. In 1970-78, Southwest Florida's total production increased 555%, but the acreage increased only 117%, indicating that productivity increased substantially. The 1970 yield was 250 cartons per acre (5.7 million cartons total) and the 1978 yield was 770 cartons per acre (17.7 million cartons total).

The important changes behind this increase in productivity are linked to the use of "culture under synthetic mulch, plug mix seeding, container-grown transplants, soil fumigation, and use of ethylene for ripening, cultural and harvesting labor on a piece work basis rather than hourly or daily, and other related technological advances" (Institute of Food and Agricultural Services 1975). The current wholesale dollar price of tomatoes rose from $4.89 a carton in 1970 to $6.34 a carton in 1978. Yet, the real price of tomatoes fell about 4.3% annually, and retail prices increased less than 1%.

Milk

Dairy products rank first among animal products in Southwest Florida. Fluid milk is the single most valuable dairy product and contributes a bulk of Southwest Florida's milk production. In 1978, about 418 million lb or 24.8% of the State's milk was produced in Southwest Florida. The number of milk cattle in 1978 was 187,000 for the State and 42,250 for the region. On the average, Southwest Florida's milk cows are more productive (11,389 lb of milk

per cow per year) than that for the State (10,417 lb of milk per cow per year). Cash receipts generated by the sale of fluid milk to commercial plants was $61.6 million in 1978 dollars, or $31.5 million in real dollars, an increase of 15% over the last decade. The 15% increase in cash receipts, adjusted for inflation, was much better than the national increase of 8.0% for milk cash receipts and Florida's increase of 11.0%. Hillsborough and Pasco Counties, which are the main dairy areas, accounted for over 75% of the dairy production in Southwest Florida in 1978.

The real price of milk received by farmers has remained virtually unchanged since 1970. Real prices declined about 0.3% annually, but that amount is not statistically significant. The current dollar price received by farmers rose from $7.41 per 100 lb in 1970 to $12.80 per 100 lb in 1978. The real retail price of milk at the grocery store has declined less than 1% annually.

The per capita consumption of milk in Florida currently is 236 lb per year. Despite increased productivity from 3.200 kg milk per cow in 1970 to 3.900 kg in 1979, additional milk has been imported to meet the State's need.

Beef Cattle

The beef cattle industry in Florida in 1968-80 ranked second only to oranges in total value. Both Florida and Southwest Florida are calf-cow producers. A majority of cattle and calves are shipped west to be fattened. In general, the beef industry in Southwest Florida has been increasing, but production tends to fluctuate up and down. In the 1978 census, beef cattle were reported in only five counties of Southwest Florida. Figures for the other counties were not released to avoid disclosure. The five counties accounted for 9.6% of the State's production, but it would be substantially higher (as high as 17%) if the statistics of all counties in Southwest Florida were available. Current dollar cash receipts in 1978 for Southwest Florida were $60.8 million or $31.2 million in real (1967) dollars. Hillsborough County is the major beef producer.

The real price of cattle and calves received by farmers has risen 13 cents per pound in 1955 to 22 cents per pound in 1978. For an inelastic demand for beef, total revenue has increased because the percentage change in demand is less than the percentage change in price. Real prices at the retail level have increased in 1954-78, but by less than 1% annually. This rise in prices is a result of demand growing faster than supply. Productivity has not kept pace with the growth in income and population.

Eggs

Egg production is greater than poultry production in Southwest Florida. Hillsborough and Pasco Counties are the two highest producers of eggs in the State. Together they account for over 40% of the State's hens and pullets of laying age. About 5,951 layers produced 1.4 billion eggs in 1979. This information was furnished by the Florida Crops and Livestock Reporting Service which reports only major egg producing counties. In 1978, Southwest Florida reported 4.6 million layers (35.6% of the State's total), a sizable increase in egg production since 1954. This increase was due primarily to the rapid

increase in the number of layers, the use of new feeds, disease control, and the introduction of mechanization of egg production from laying to packaging. Productivity has increased from 217 eggs per layer in 1970 to 244 eggs in 1979. The number of layers and eggs produced by county, region, and State are listed in Table 14. The Tampa area in Hillsborough County is the State's leading egg producer. Cash receipts from egg sales were nearly $38.8 million in current dollars and $19.6 million in real dollars, an increase of 56% since 1970.

Southwest Florida's egg production is growing faster than that of the State (Table 14). In 1970-79, the region's egg production (eggs per layer increased from 217 to 244) grew about 64%, but the State's production grew only 25.6%. The income from egg production was about 8.7% of the cash receipts from the sale of all agricultural products.

The real price per dozen of eggs received by farmers steadily dropped from 1970 to 1979 at an annual rate of 3.3%, and real retail prices dropped 1.9%. The difference in the rate of change between farm and retail prices was caused by a more rapid increase in productivity (technological change) at the farm level than at the distribution, processing, and retail levels. When egg prices drop, consumer demand for eggs tend to increase.

Table 14. Egg production and retail prices for 1970, 1975, and 1979 (Florida Crop and Livestock Reporting Service, Annual Poultry Summaries for 1970, 1975, 1979).

Year	Current price per dozen	Southwest Florida		Florida	
		Layers (thousands)	Eggs (millions)	Layers (thousands)	Eggs (millions)
1970	$0.34	4,082	886	12,283	2,540
1975	0.44	4,121	972	11,799	2,779
1979	0.49	5,951	1,452	1,049	3,189
Percentage increase					
1970-79	0.45	45.8	63.9	6.2	25.6

Other Products

Southwest Florida is a major producer of many of the State's vegetables. Based on differences in soil, there are two areas of production. The northern area, comprised of DeSoto, Hillsborough, Manatee, Pasco, Pinellas, and Sarasota Counties, is a major producer of tomatoes, celery, cabbage, cucumbers, and bush and pole beans. The southern area (Charlotte, Collier, Lee, and Monroe Counties) is a major producer of green peppers, tomatoes, sweetcorn, cucumbers, and watermelons.

Oranges, tomatoes, dairy products, eggs, and beef cattle contribute over 75% of Southwest Florida's agricultural income. Other commodities may be important to a county but not necessarily to the region. Less important agricultural products are celery, cucumbers, peppers, squash, lettuce, field peas, hogs, bees, and honey.

Cucumbers. The production of cucumbers in Florida was 4.8 million bushels in 1979, up 8% from 1978. About 80% was marketed fresh and 20% was processed. About 15,700 acres were under cultivation for cucumbers. Southwest Florida accounted for 35% (6,500 acres) of the State's cucumber acreage, and about 34% of the State's total production of 1.6 million bushels. Cucumber production yielded the region $13.2 million in cash receipts.

Green Peppers. Southwest Florida, with only four counties reporting (Charlotte, Collier, Hillsborough, and Lee Counties), accounted for about 48% of the State's total acreage and production of green peppers in 1979. In 1974-79, the acreage in Southwest Florida increased 49% (13,400 acres in 1974 to 8,510 acres in 1979), bringing about $24 million in revenue to area farmers.

There are many other agricultural products grown in the region, but detailed information on either a county or regional basis is not available.

AGRICULTURAL PROBLEMS AND POLICIES

Major problems in Southwest Florida are conflicts among land use, water use, environmental protection, rising energy demands and costs, and competition for markets.

LAND USE

Most apparent to Florida's farmers is the "disappearance" of agricultural lands. The Florida House of Representative's Committee on Agriculture has prepared a report on this issue entitled "Agricultural Lands in Florida" (1981b). That report begins with the observation that Florida's agricultural lands are slowly being converted to other land uses. Agricultural land is used for new homes, schools, shopping centers, airports, industrial parks, recreational areas, and other uses associated with a growing urban population and phosphate mining. The report contends that Florida, as one of the fastest growing states, will continue to put an inordinate demand for "new" land. Some of the loss of prime and unique farmlands is irreplaceable, a focal point of the Committee's argument for the retention of agricultural land. To combat this loss, the Committee recommended more comprehensive land use plans, extensive soil surveys and mapping, elimination of any State project that might have serious adverse impact on farm lands, and the monitoring of local land use alteration or development.

The Committee's report does not identify economic reasons why the trend in agricultural land loss is necessarily undesirable, unproductive, or socially unacceptable. Recently there has been much discussion and concern over the disappearance of farm land because of its impact on future genera-

tions, and the capacity of the remaining land to support and sustain the population.

The change of agricultural lands to other uses is the natural response of any freely functioning market. So far, agricultural production is rising faster than the land is disappearing. In 1954-78, the area of agricultural lands in Florida declined 26%, whereas production increased 146%.

When the market system is functioning normally, the price operates as a signal. The rise in land values signals the farmers to lower their costs by using less expensive capital and labor. This shift allows resources to be utilized by those who value them the most and permit a more efficient allocation of resources. Efficiency increases because it forces the farmers to use least-cost methods of production and become more productive with the resources at hand.

There is yet another viewpoint on the changing pattern of land use. Perhaps it is not the demand of nonfarm land users that is responsible for the loss of agricultural lands. Improved technology has increased productivity per acre and decreased the agricultural sector's need for land. Farmers find that they can produce more with less land, and cut expenses and raise revenue by selling land. In short, the farmer is releasing land for other uses. Generally, urban populations cannot increase without the use of additional land.

ENVIRONMENTAL CONFLICTS

Florida is no longer a frontier land where the conflicts among industry, agriculture, cities, and citizens were not major environmental issues. Only a few decades ago pollution was at low levels and chemicals were natural, biodegradable, and deteriorated in a short time or turned to sediment. Land, timber, water, and other resources were abundant. After intensive land development, these land uses often are in serious conflict. Examples are the emissions from a fossil-fueled power plant that may indirectly damage forests, crops, lakes, and even buildings because of acid rain. Chemicals and pesticides often are used without much restriction. These are often made of synthetic compounds which take many years to break down and complicate nature's capacity to assimilate them. Further conflicts are given in the following sections.

Pesticides and Chemical Fertilizers

To quote Seneca and Tausig (1979):

> In the long-run perspective of history, the development and extensive use of effective pesticides have made a major contribution to human welfare. Pesticides are responsible for enormous increases in agricultural yields and for the control of once widespread and debilitating diseases. Pesticide research findings again reveal the recurring theme of environmental problems, a difficult, benefit-cost type of decision whether, and to what degree, to continue pesticides

use and gain protection of crop yields and lower incidences of some human diseases at the cost of considerable long-run damages to environmental conditions and increased risks to human health.

Insecticides may not only destroy insects and a wide range of other land animals, but some of the chemicals are carried by runoff into lakes and rivers. Some waters may be so badly polluted that fish and other aquatic organisms may die. Long-term effects are contamination of drinking water and chemical accumulation in the food chain.

Nutrients in runoff from farm lands that are enriched by chemical fertilizers may cause accelerated eutrophication in the receiving waters. The results may be noxious algal growth, excessive aquatic plant growth, and in some cases, oxygen depletion and fish kills. Water hyacinth in Florida is a particularly difficult problem. These floating plants clog waterways and lakes, tie up nutrients, and obliterate underwater photosynthesis. Practical control of these plants is unknown.

Eventually the use of pesticides and chemicals may be reduced without decreasing the yield and quality of farm products. The use of strong, more resistant plant strains, sterile males, insects that feed on pests, enforced diseases, and the use of radiation are means of combating pests and parasites without chemicals or pesticides. Currently, experiments are underway, but new methods of control are not working. The rising price of petrochemicals that produce many of these pesticides and chemicals may make other means of pest control much more attractive in the future.

Animal and Human Wastes

Animal wastes (from feed lots for example) are another major pollution problem confronting farmers. These wastes enter ponds, lakes, and rivers primarily through runoff. Rainfall is abundant in Southwest Florida, and runoff from manure is a major concern in some areas. The solution may be that both animal wastes and urban sewage will be used for feed and fertilizers.

Energy

Energy is a problem, not because there is an energy crisis, but because of the burden imposed on farmers by the rising cost of production. In Southwest Florida, farmers rely on petroleum and petroleum products in all phases of production and marketing. Use of chemicals, pesticides, machinery, tractors, and transportation services will expand as farmers are called upon to increase output. Despite the importance of oil and electricity in farm operations, consumption by this sector accounts for only 3% of U.S. energy consumption and less than 5% of Florida's energy consumption. In 1978, petroleum made up 75% of all energy used in agriculture. Use of petroluem for energy on Florida's farms increased 35.7% in 1974-78. The energy expended on production, food processing, transportation, wholesale and retail trade, and home storage and processing is only about 12% of the total U.S. energy use (Smerdon 1975).

The challenge of the next decade will be for farmers to increase production as the population increases and to apply even more energy efficient farming methods. Research is underway on solar methods for drying agricultural

products, and studies are being conducted on new methods of irrigation that will reduce both water and energy use and help protect crops from the cold. Such methods would lower the use of outdoor heaters that are now protecting citrus and vegetable crops from winter freezes in Florida. The development of new disease resistant and high yield crops will lessen energy use. These methods and many others are now being studied to help conserve energy.

Labor

In Florida, labor in the past has been unskilled, relatively cheap, and seasonal. As the trend in increasing farm size and mechanization continues, unemployment patterns also will change. Increased skills and training of farm laborers are now needed for the operation and maintenance of farm machinery and new cultivation practices (Covery 1975). The need for this skilled labor will bring farmers into direct competition with industry, thereby forcing farmers to raise wages to retain or attract new workers. In addition to raising wages, farmers must increase productivity if they are to maintain profits.

Air Pollution

Agricultural damage from air pollution is difficult to assess. The major effluents responsible for damage to crops and livestock are sulfur dioxide, ozone, and fluorides. In Southwest Florida, the major source of these pollutants is industrial and utility plants.

Sulfur dioxide from smoke stacks or other methods of emission entering the atmosphere are absorbed by plants through the respiratory process and if in excess it may become toxic to plants (Seneca and Tausig 1979). While in the upper atmosphere, sulfur dioxide combines with moisture and falls to earth as acid rain. Acid rain bleaches the soil, rendering many of its minerals inert and incapable of supplying needed nutrients to plants. The result is decreased productivity and increased cost to the farmer. Acid rain also damages leaves and roots. A comprehensive study of acid rain and its impact on the environment was begun in 1978 by the Florida Department of Environmental Regulation (DER).

In the 1950's and the 1960's, flourides and ozone caused considerable damage to crops and beef cattle in Polk County where substantial amounts of fluoride were released from phosphate mining. Similar damage was apparent in Pasco and Hillsborough Counties. Fluorides and ozone enter the leaf system and interfere with photosynthesis and plant food production. When plants laden with fluorides are eaten by livestock, the animals contract fluorosis. Fluorosis symptoms are loss of weight, reduction of growth, lack of mobility, and sometimes death. Ozone damages the leaves and plant cells and destroys plant life. Ozone pollution is most evident in heavily industrialized areas.

Water Use

Water use is a seasonal concern, not only to farmers in Southwest Florida, but to all inhabitants. The combination of droughts, irrigation, phosphate mining, industrial use, and urban use have periodically created water shortages. In Southwest Florida, intensive water use and drought lowered the water level in the Everglades, endangering valuable wetlands and wildlife. In the future, greater competition between agricultural and nonagricultural water

use may cause local short-term water shortages. Water resources are valuable to Southwest Florida, and future use and allocation will probably be determined by government action. Seasonal shortages of water may pose a serious challenge to area farmers. To overcome this threat, farmers are likely to seek new methods of irrigation, water retention, and water management.

AGRICULTURE'S IMPACT ON THE ECONOMY

Economic indicators that measure the performance or impact of agricultural and other sectors range from aggregate indicators to multipliers. Aggregate indicators such as employment and income are measures of economic activity. Multipliers are used to predict economic change as the sector grows or declines.

In a recent study (Loehman and Hsiao 1979), the value of income, output, employment, and import multipliers was calculated for Florida to express economic change per dollar of final demand. Final demand consists of the demand (purchase) of goods at the retail level.

OUTPUT AND OTHER MULTIPLIERS

Output multipliers give an estimate of the change in total output (dollar value) per change in final demand. In 1970, the agriculture and forest products processing sector in Florida had four of the top five ranked multipliers (ranked by size of multiplier). These subsectors included frozen package foods, paper products and processing, meat and milk processing, and fish processing. Primary production multipliers are listed in Table 15.

Table 15. Agriculture output multipliers (Loehman and Hsiao 1979).

Commodity	Output multiplier
Agricultural services	1.538
Livestock products	1.477
Field crops	1.470
Vegetables and sugar	1.379
Fruits and nuts	1.368
Forest and nursery	1.267

For each dollar increase in final demand (in and out of Florida), the dollar value of output related to farm production (i.e., support services, processing, etc.) will increase 47.7% for livestock, 47.0% for field crops, 37.9% for vegetables and sugar, 36.8% for fruits and nuts, and 26.7% for forest and nursery products. The dollar value of agricultural output will increase 53.8%.

Income Multipliers

The fruits and nuts industry has the highest income multiplier. When demand and output increase by one dollar, the region's income should increase by a multiple of 1.397 for fruits and nuts, 1.380 for vegetables and sugar, 1.370 for field crops, 1.329 for livestock products, 1.292 for forest and nursery products, and 1.329 for agricultural services. If the output increased by $1,000 in the fruits and nuts industry, then direct and indirect income will rise to $1,397.

Employment Multipliers

These multipliers are obtained by dividing the total employment in all sectors of the economy by direct employment per dollar output. Field crops have the largest employment multiplier. When demand for agricultural commodities increases by one dollar, the impact on employment is a multiplier of 1.749 for field crops, 1.353 for fruits and nuts, 1.308 for livestock products, 1.253 for vegetables and sugar, 1.220 for forest and nursery products, and 1.242 for agricultural services.

Export multipliers

An increase in employment in basic industry will have a secondary impact on nonbasic industries. This secondary impact is known as the export multiplier. The rate of growth is determined by its function as an "exporter" outside the region. Export of products from Southwest Florida channel outside dollars into the region and trigger chain reactions of additional economic activity. The process of each dollar being respent and causing new impacts is not infinite. At each round of spending, some dollars leak out of the economy in the form of savings, taxes, profits to stockholders outside of the region, and as payments for imported goods and services. The total respondent process associated with each additional dollar of sales is called the "multiplier" effect. Multipliers are useful to predict economic expansion due to growth in sectors of the economy.

According to Loehman and Hsiao (1979), there are various economic indicators which can be used to analyze the role of economic sectors in the economy. The various aggregate indicators and multipliers relate to different aspects of economic welfare. A sector with low output multipliers may be important to the economy because of large numbers of people employed. On the other hand, a sector with low employment may have multipliers and hence be important in an expansionary sense.

Loehman and Hsiao (1979) have further pursued the subject of agriculture's impact on the Florida economy. Multiplier analysis often understates a sector's full impact because it measures only changes dealing with final demand. Tables were constructed showing the breakdown of basic agricultural sales to processing and final demand for 1963 and 1970. Fishing and forest products have a low output multiplier (1.239), but this is because over 90% of sales are to processers and very little to final demand. When the related processing sectors are examined, they have high multipliers and large exports. All but three of the food and wood processing sectors rely solely on agriculture. In 1970, total employment attributable to agriculture comprised 16.7% of the State's total work force, whereas basic agricultural employment was only 7.7%. Personal income related to agriculture was 21.1% of total income,

although personal income derived from basic agriculture was only 13.5% of the State's total personal income. The findings of Loehman and Hsiao on Florida's agricultural sectors' impact on the economy are reported in Table 16. In all sectors the writers believe that the impact of agriculture on other sectors is much greater in Southwest Florida than in other areas of the State. This is because the region is a major producer of many of the State's farm products and also because of its well developed and sophisticated industrial and commercial base.

Table 16. The contributions of agriculture to the Florida economy in 1970 and (in parentheses) percentage contribution to the State total (Loehman and Hsiao 1979).

Sector	Employment relating to basic agriculture (x 1,000)	Personal income ($) relating to basic agriculture (x 1,000)	Value ($) added relating to basic agriculture (x 1,000)
Basic agriculture			
Agricultural services	12,527	53,760	85,606
Livestock products	29,080	166,219	126,429
Field crops, tobacco	4,551	57,648	61,484
Fruits and nuts	28,414	136,914	177,843
Vegetables and sugar	22,191	79,266	102,877
Forest, greenhouse and nursery	9,435	40,354	62,192
Fishery products and forestry	1,566	7,104	8,099
Subtotal	107,764 (5.6)	541,267 (4.8)	624,530 (3.3)
Employment related to agriculture			
Mining	262 (0.0)	1,896 (0.0)	7,442 (0.0)
Construction	1,480 (0.1)	10,544 (0.1)	16,529 (0.1)
Food and wood processing	86,787 (4.5)	539,656 (4.8)	1,090,927 (5.7)
Other manufacturing	10,335 (0.5)	72,994 (0.7)	107,055 (0.6)
Utility and transportation	7,432 (0.4)	56,941 (0.5)	147,463 (0.8)
Trade	18,393 (1.0)	119,662 (1.1)	118,201 (0.6)
Finance, insurance, real estate	3,391 (0.7)	21,731 (0.2)	75,433 (0.4)
Services	12,614 (0.7)	74,335 (0.7)	71,921 (0.4)
Government and ordinance	368 (0.0)	3,620 (0.0)	1,875 (0.0)
Subtotal	141,062	901,379	1,636,846
TOTAL	248,826	1,445,646	2,261,376
Ratio of total to basic	2.61	2.96	4.20

AGRICULTURE AND OCS OIL AND GAS DEVELOPMENT

Although currently there are few interactions between the agricultural sector of Southwest Florida and OCS oil and gas exploration and development, two potential threats should be considered. The start of intensive offshore drilling could exact new demands on the labor market. The relatively higher wages of oil workers, approximately $12 per hour (Charter Oil Co. August 1982) as compared to farm hands, $3.34 per hour in 1980 (Greene et al. 1980) would attract farm workers and possibly cause a temporary labor shortage.

Long term and potentially the most costly conflict between agriculture and OCS oil and gas production is the prospect of increased air pollution from refineries built locally (see reports in this volume about minerals and oil production, and environmental issues and regulations). Sulfur dioxide is one of the main pollutants emitted during oil refining and heavy concentrations kill plants. Sulfur dioxide in gaseous form combines with moisture in the atmosphere and forms acid rain. Acid rain can seriously acidify natural, unbuffered fresh waters or leach the soil and damage roots and leaves (Florida Sulphur Oxides Study Inc. 1978).

Other than these two potential problems the writer can see no other possible conflicts between OCS oil and gas development and the agricultural sector. The short run labor conflict is the product of an efficiently operating market. The conflict involving air pollution is the result of an externality, where the market does not operate efficiently. It is beyond the scope of this paper to estimate the potential damage from pollution to farmers. In short, it is anticipated that OCS leasing, if it has these impacts, will raise costs for both the farmer and the consumer and may lower yields and output thus raising consumer prices even higher.

AGRICULTURAL PRODUCTION PROJECTIONS

Two sets of primary agricultural production projections are described here. The first set is derived by the writers, the second from the "OBERS Florida Agricultural Projections."

PROJECTIONS, SET 1

For the purpose of these projections, it is assumed that agricultural projection or supply is perfectly elastic in response to any change in demand; therefore, the <u>real price of these commodities</u> is assumed to remain constant. The demand for farm products is a function of the growth of the population and real per capita income. Mathematically it can be expressed as follows:

$$[Q_D]_T = [\ P/P + Ey/n\ \frac{PI}{PI}][Q]_B$$

where Q_D is the quantity demanded at time period T in Southwest Florida; P/P is the percentage change in the U.S. population; Ey/n, the income elasticity; PI/PI is the percentage change in real per capita disposable income; and $[Q]_B$ is the base period (1978) for projections to 2030. Because most agricultural products produced in Florida are sold in a national market, the

projected increase in population nationally is used in the equation. Because it is assumed that supply is perfectly elastic, then the quantity demanded equals the quantity supplied. The equation above serves a forecasting function, based on Engels' law which relates income to consumption. Engels observed that the income elasticity for food was quite low and that as income rose people spent a lower percentage of their income on food. There is a point where any increase in income would not induce people to spend more on food and it is for this reason that income elasticity is excluded as a component of demand past the year 2000. The exact date when, if ever, the income elasticity becomes zero is unknown, but rough adjustments for Engels' law are made in these forecasts. It is also assumed that any loss of farm acreage will be matched by increases in productivity as this has been the historical trend and can be counted on to continue for some time. Although real wholesale prices fell when retail prices rose, the assumption that real wholesale and retail prices will remain constant is a realistic simplifying assumption in the absence of knowledge of the contrary. Population and income projections were furnished by the Water Resources Management Council, OBERS (1972). Major agricultural commodity projections until the year 2030 are given in Table 17.

PROJECTIONS SET 2

These projections were made by using 1978 as a base year and projecting to the year 2030 using OBERS' population and income growth rates. OBERS' projections of aggregate demand for domestic food are based upon the projected rates of population growth and projected level of per capita consumption. Income of the latter is related to projected levels of per capita income. These projections reflect specified relationships between product consumption and income potentials for product substitution and price elasticity of product demand. The writer then used the State's growth rates and applied them to the region (Table 18).

A comparison of set 1 and set 2 indicates that for all commodities, except tomatoes, OBERS' projections are much higher than the authors' projections. This is likely because the writer suspended the impact of income elasticity after the year 2000, whereas the OBERS' study decreased the income elasticity over time. It could also be the result of different elasticities.

Table 17. Agricultural production projections (set 1) for Southwest Florida for intermittent years from 1978 to 2030 (Bell and Addison 1981).

Commodity	1978	1985	1990	2000	2010	2020	2030
Oranges (boxes)	30,411	34,025	37,091	43,150	45,876	48,000	51,487
Tomatoes (cartons)	17,680,000	22,739,000	26,755,000	37,631,000	40,008,000	43,384,000	44,901,000
Milk (million lb)	481	539	583	676	719	761	806
Beef cattle (number)	197,906	222,895	241,895	281,768	299,768	317,571	336,432
Eggs (thousands)	1,088	1,148	1,197	1,262	1,342	1,422	1,506

Table 18. Agricultural production (set 2) projections for Southwest Florida for intermittent years from 1978 to 2030 (Bell and Addison 1981; Water Resources Council 1972).

Commodity	1978	1985	1990	2000	2010	2020	2030
Oranges (boxes)	30,411	40,474	42,457	46,405	49,282	52,141	55,165
Tomatoes (cartons)	17,680,000	24,046,000	24,719,000	26,019,000	27,800,000	29,524,000	31,355,000
Milk (million lb)	481	541	569	627	700	774	855
Beef cattle (number)	197,906	242,400	260,900	297,600	319,100	340,000	363,000
Eggs (thousands)	1,088	1,263	1,380	1,636	1,815	1,994	2,191

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MINERAL AND OIL RESOURCES

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INTRODUCTION

Florida is the world's leading producer of phosphate and ships phosphate products worldwide. It imports large amounts of refined and finished petroleum products, primarily from U.S. oil companies. In addition to phosphate, major minerals produced in Florida are petroleum, limestone, titanium, zircon, earth concentrates, and cement.

This paper focuses on the mineral production of Southwest Florida in Monroe, Collier, Lee, DeSoto, Charlotte, Sarasota, Manatee, Pinellas, Hillsborough, and Pasco Counties. A historical and geological perspective is provided, together with current and projected production of minerals. In addition to information on mineral production, related issues such as employment, value of shipments, and potential impacts of mineral production are discussed. This information should be useful for environmental planning and to public and private agencies and individuals. Emphasis is placed on phosphate production in the region and on the facilities potentially needed for Outer Continental Shelf (OCS) oil production. Although there is modest onshore production, there have been no offshore discoveries; however, potential discoveries warrant planning for possible onshore impacts. Consequently, much of this paper provides generic information on OCS oil and gas development and their potential impacts.

Nonfuel mineral production in Florida contributes materially to its gross product and has increased rapidly since 1940. The value of production increased from about $15 million in 1940 to almost $109 million in 1955, an increase of 730%. Between 1960 and 1977 the value of production rose from about $177 million to $1.7 billion, an increase of 815%. The rapid increase can be attributed largely to the discovery and production of petroleum in the Jay field in Northwest Florida.

By 1978, Florida was the sixth largest nonfuel mineral producer in the United States, and its value ranked ahead of that of the traditional mining States of Arizona, Colorado, and Utah. In 1978, mineral production (excluding fuels) was valued at over $1.0 billion. Phosphate rock was the leading mineral commodity followed by petroleum, cement, and stone (crushed limestone, dolomite, and shell-rock) (U. S. Department of the Interior 1978).

Florida not only ranked first in the Nation in the production of phosphate rock, it also ranked first in titanium concentrates and zircon, second in fullers earth and rare earth concentrates, and sixth in stone. In 1978, phosphate rock contributed over half (over $600 million) of the State's total nonfuel mineral value, followed by cement ($110 million), and stone ($118 million). The total value of crude oil, natural gas liquids, and natural gas was $709,053,000, about 39% of the value of all minerals. In terms of the State's

economy, the principal mineral products in order of value are phosphate rock, crude petroleum, and limestone.

The ten county area of Southwest Florida is prominent in fuel and nonfuel mineral production. The nonfuel minerals produced are phosphate, limestone, cement, sand and gravel, and oyster shell. Phosphate is by far of greatest value. DeSoto, Hillsborough, and Manatee Counties are estimated to contain 442 million metric tons of phosphate reserves, which is about 13% of all known reserves in North America. About one-third of the phosphate rock is shipped out of the State, either to foreign or domestic destinations, for further processing into final products. In 1978, the leading export from Tampa Port (the third ranked port in the nation in terms of export tonnage) was raw phosphate rock to be used for fertilizer.

REGIONAL GEOLOGY

INLAND

Florida is the second largest (58,600 mi^2) State in the southeast. It lies entirely within the coastal plain province, a major physiographic division of the United States. It is underlain by sedimentary rock with a thickness of more than 1,200 m (4,000 ft). The surface mantle over much of the State is composed of soils and sands up to 61 m (200 ft) deep (Calver 1957). The State has a variety of mineral resources and industries (Figures 1 and 2).

The counties of Southwest Florida are underlain by a thick sequence of sedimentary layers. Beds older than Late Miocene do not crop out in Southwest Florida. The Late Miocene is represented by the Tamiami Formation of undetermined thickness. Pliocene deposits are unknown and the Pleistocene is represented by the Caloosahatchee Marl and the overlying Fort Thompson Formation. Average thickness of the Pleistocene formation is between 8 m (25 ft) and 23 m or 75 ft (DuBar 1962). Below those formations, which tend to be exposed, are formations of the earlier Hawthorn and Tampa Miocenes. Series below the Miocene include the Oligocene, represented by the Ocala Limestone, Avon Park, Lake City, and Oldsmar formations (Florida Department of Administration 1978).

All of Southwest Florida lies within the Southern or Distal Zone of the Coastal Plain Province (White 1970). The basic geology of the region consists of relatively young sedimentary formation, with most of the coastal lowlands covered by unconsolidated marine and estuarine terrace deposits of the Pleistocene or more recent age. Most of the region is covered by sand and clay that have relatively limited economic value. Large areas in the southwest are covered by valuable phosphate and peat reserves.

The mineral industry in Southwest Florida is supported largely by phosphate production and modest amounts of petroleum. Onshore oil and gas production is confined largely to the Sunniland Field in Collier County. Oil and gas production in the southwest may be attributed to lower crustaceous limestone (Trinity Age) from the Mesozoic Era (Babcock 1964). The producing zone of this formation has been named Sunniland and is at a depth of about 3,505 m (11,500 ft) (Calver 1957).

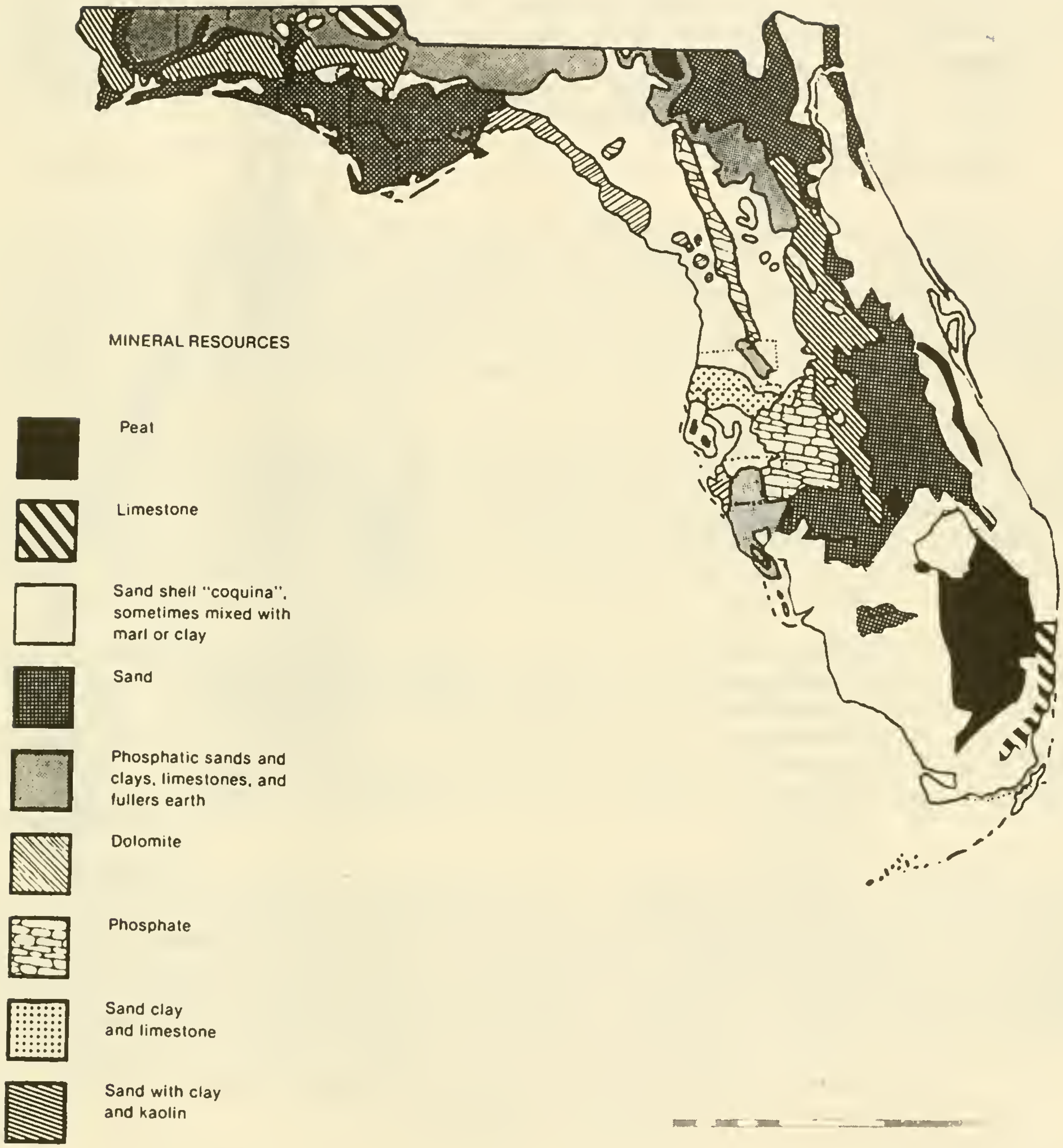

Figure 1. Florida mineral resources (Wood and Fernald 1974).

Figure 2. Florida mineral industries (Wood and Fernald 1974).

Natural rock containing one or more phosphate minerals (usually calcium phosphate) is generally referred to as phosphate rock. Phosphate rock is neither constant in composition nor occurrence and consists of a variable mixture of calcium phosphates and other minerals. X-ray studies have shown that the dominant phosphate mineral in Florida deposits is fluor-apatite found in the extensive bedded deposits of marine origin. Studies by the United States Geological Survey (USGS) have shown that the phosphates of the Bone Valley formation and the Hawthorn formation are of marine origin (Calver 1957). These deposits are sedimentary beds of phosphate pebbles, sand, and clay located in Hillsborough and nearby counties. The hard rock phosphate deposits, on the other hand, were formed by weathering of surface rocks, and the deposition of phosphate as replacement for limestone is not of marine origin.

OFFSHORE

Hydrocarbon-bearing formations in the Gulf of Mexico are generally associated with sub-seabed vertical salt movements that form salt domes. Under the weight of the overlying beds, salt is squeezed upwards, piercing sedimentary beds, and arching. Those that are closer to the seabed surface form into domes. The domes are typically topped by caprock. Oil and gas accumulates along the flanks of these salt domes (U.S. Department of the Interior 1980a).

The West Florida Shelf and Slope extends from the DeSoto Canyon in the Gulf of Mexico eastward to The Straits of Florida in the Atlantic Ocean. Geologically, it is considered the submerged extension of peninsular Florida. Interest in Southwest Florida has been scattered in areas known as the Florida Middle Ground, Tarpon Springs, the Elbow, Saint Petersburg, and Charlotte Harbor. Salt domes and anticlines within these areas are the principal exploratory drilling targets of industry seeking oil and gas fields.

Industry's present interest in the Eastern Gulf of Mexico is focused on the Howell Hook and Pulley Ridge areas on the Outer Continental Shelf. Both of these areas are south of parallel 26°, about 161 km (100 miles) west of Fort Myers in Lee County. It is theorized that a continuation of the geophysical and geological characteristics in the Sunniland basin extend to the Outer Continental Shelf, and that oil and gas resources there may be in commercial quantity.

Recently there has been speculation that an abundance of phosphate lies in the Gulf of Mexico's continental shelf waters. Scientists from the University of South Florida believe that phosphate deposits may extend from the City of Apalachicola to the Keys. The heaviest concentration appears to be between 16 km (10 miles) and 96 km (60 miles) off the coast of Clearwater. In June 1981 two USGS research vessels conducted additional studies on the phosphate potential of the Gulf of Mexico (Tallahassee Democrat 1981).

THE MINERAL INDUSTRY

Minerals that are of economic importance in Southwest Florida are phosphate, petroleum, peat, limestone, cement, and sand. Other than phosphate and petroleum, peat is perhaps the most important mineral. Major peat deposits are the Everglades, and Corkscrew Marsh. The mining of peat historically

falls into three eras. First, muck and peat areas were drained for agricultural cultivation early in this century. Second, peat was used as an energy source. In 1905, the first plant for the conversion of peat to briquets was constructed. Ideas for the use of peat for fuel prevailed into the 1920's. The conversion of peat to fuel now is too costly. Third, peat is used primarily for humus and fertilizer. Between 1917 and 1945, 200,000 tons of 50 percent air-dry peat were mined (Davis 1946).

A mineral which has recently gained economic importance is uranium, a byproduct of the phosphate industry. Areas that are rich in phosphate often contain relatively high concentrations of uranium. Several other minerals are scattered throughout Southwest Florida, but are not important.

COUNTY PROFILES

The amount and value of most minerals produced in Southwest Florida are not available from publications open to the public. Specific data by county and, in the case of phosphate for the State, are withheld so as not to compromise the competitive positions of individual producers and operators. In a few instances figures were obtained. For example, in 1965 phosphate production in Hillsborough County was valued at $27,344,000 or 19% of the total value ($141,258,000) of mineral production for the State (U. S. Department of the Interior 1965).

In 1978, oil and gas production contributed $42,753,000 to the economy of Southwest Florida. This amount was 6% of the total oil and gas production for the State and 2% of the State's total mineral production (U. S. Department of the Interior 1978).

Limited profiles for each county in Southwest Florida based largely on 1972 data are given in the following subsections (U. S. Department of the Interior 1960, 1970, 1975).

Charlotte County

No data are available.

Collier County

In 1972, petroleum was the most valuable mineral produced, followed by limestone and natural gas. The 18 mineral producing establishments employed about 1,000 workers. The payroll was about $1.1 million, which added $4.2 million to the State's economy. Capital expenditures were $1.7 million. Seventeen establishments, all in oil and gas extraction, employed between 1 to 19 employees. One establishment in nonmetallic mineral mining employed between 20 and 99 employees.

DeSoto County

DeSoto County reported one establishment in oil and gas extraction. No other data were available.

Hillsborough County

Cement, followed by phosphate, oyster shell, and gems were the most valuable minerals produced. In 1967 and 1972 there were 9 and 10 establishments, respectively, in the minerals industry. About 500 workers were employed in minerals industries in 1967 representing a payroll of $3.1 million. In the same year, mineral industries added $14.3 million to the State's economy. Of the 10 establishments reported in 1972, 8 were in nonmetallic mineral mining and 2 in oil and gas extraction.

Lee County

Limestone, oyster shells, and gems, in that order, were the most valuable minerals produced. In 1972, several establishments employing between 1 and 19 workers were reported. Of these, 4 were nonmetallic mineral mining and 3 were oil extraction.

Manatee County

Cement and stone were the most valuable minerals. In 1972, four nonmetallic mineral mining establishments employed between 1 and 19 workers.

Monroe County

Limestone was the most valuable mineral. In 1974 and 1975 mineral production was reported to be $1,296,000 and $881,000, respectively. Two establishments, employing between 1 and 19 workers, were involved with oil and gas extraction.

Pasco County

In 1974 and 1975, the value of mineral production (mostly stone) was $611,000 and $343,000, respectively. In 1972, one establishment in nonmetallic mining employed between 1 and 19 workers.

Pinellas County

In 1972, there were 18 mining establishments. Twelve were in stone production and six were in oil and gas extraction.

Sarasota County

In 1972, two sand and gravel mineral industry establishments employed between 1 and 19 workers, one establishment employed between 20 and 99 employees. Two establishments were in oil and gas extraction and one in nonmetallic mining.

PHOSPHATE EXPLORATION AND PRODUCTION

HISTORY OF PHOSPHATE MINING

Phosphate mining in central Florida dates back to the 1880's when large quantities of phosphatized vertebrate fossils were discovered along the Peace

River. Mining of these deposits was by hand labor and production was low (Canterbury 1978). By 1888, however, production shifted from river deposits to land-pebble deposits discovered in Bone Valley, about 25 miles east of Tampa. Production was 2,700 metric tons in 1888, 275,500 metric tons in 1892, 680,000 metric tons in 1900, 3.3 million metric tons in 1930, and 36 million metric tons in 1975 (Hoppe 1976; Canterbury 1978).

As the demand for fertilizer grew and technology advanced, the volume and efficiency of recovery increased. Nevertheless, the phosphate industry in Florida is characterized by a small number of producers because of the large capital investment required to mine phosphate (Canterbury 1978). The ten major phosphate companies in Florida produced 80% of the U.S. total in the 1950's and 85% in the 1960's. In the 1970's, 15 companies mined over 95% of the nation's phosphate rock (Canterbury 1978).

PHOSPHATE PRODUCTION

Three Southwest Florida counties fall within the 5-county Central Florida Phosphate District, an area of approximately 5,180 km (2,000 mi^2) (U.S. Environmental Protection Agency 1978). This area, sometimes referred to as the Pebble Phosphate District, or Bone Valley, is one of the world's largest sources of phosphorite or amorphous phosphate rock (Figure 3).

The rock occurs in sedimentary deposits of marine origin. Chemical analysis of phosphate rock are reported as percent phosphorous pentoxide (P_2O_5), tricalcium phosphate (CA_3PO_4), or bone phosphate of lime (BPL). One percent BPL is equivalent to 0.46 P_2O_5. Fertilizers manufactured from triple superphosphate and diammonium phosphate have about 46% P_2O_5 (Wilbur Smith and Associates 1980).

The production of the Bone Valley phosphate industry in Florida in 1976 accounts for about 80% of U.S. production and 33% of the world production. In Southwest Florida, Hillsborough, Manatee, and DeSoto Counties produce the most phosphorous. The principal activities associated with the phosphate industry are mining, beneficiation, chemical and nonchemical processing, and mineral transportation. The standard mining practice in the Florida land-pebble phosphate fields is to remove the overburden and mine the phosphate matrix with electric powdered drag lines (U.S. Environmental Protection Agency 1978).

The overburden is typically quartz, sand, and clay averaging 6 m (20 ft) in thickness. In a typical 1-year operation, 162 ha (400 acres) of land are mined and 9.9 million m^3 (13 million yd^3) of overburden and 6.9 million m^3 (9 million yd^3) of matrix are removed. In the Bone Valley area in 1976, about 2,000 ha (4,940 acres) were mined (U.S. Environmental Protection Agency 1978). The phosphate industry currently owns either the land or mineral rights to areas with enough phosphate deposits to continue the present rate of production beyond the year 2000 (U.S. Environmental Protection Agency 1978).

After the area is mined, land reclamation for strip-mine areas begins to show effects within 2 to 3 years, but the reclamation of slime-holding ponds, an integral part of the phosphate strip-mining process, may take as long as 10 years. In 1979, the following companies engaged in phosphate mining in Southwest Florida: International Minerals and Chemicals Corp. (IMC); Brewster

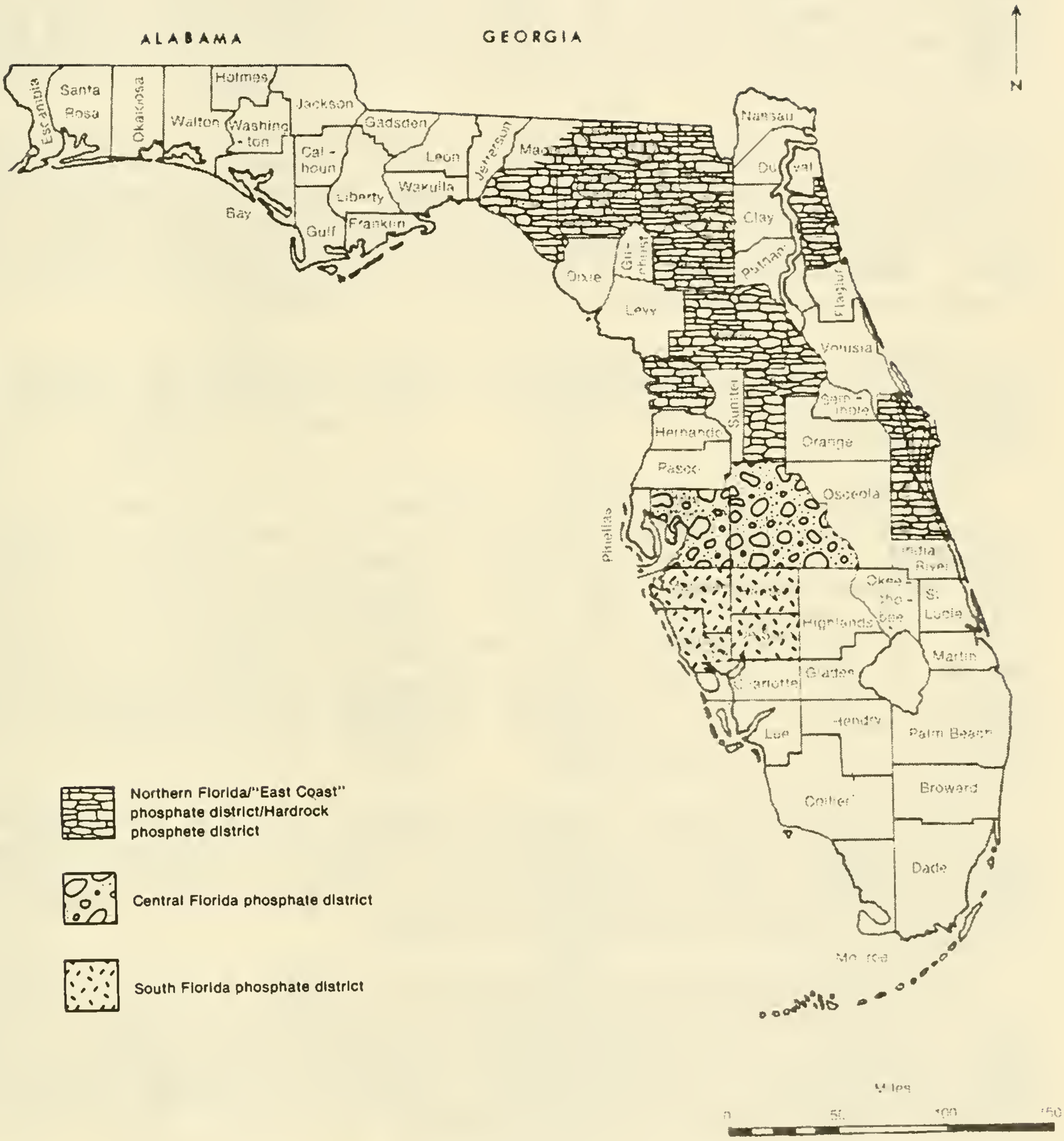

Figure 3. Florida counties with identified phosphate deposits (Zellars-Williams 1978).

Phosphates at Fort Lonesome; and Borden, Big Four Mine (Wilbur Smith and Associates 1980).

As the phosphate industry expands to meet consumer demands, a number of new phosphate mines will be developed. Several are scheduled for Southwest Florida (Table 1).

Beneficiation is a process used to upgrade phosphate ore. In order to remove impurities, a mechanical process involving washing, milling, screening, clarifying, separating, and floating is used. These processes require large quantities of water as high as 10,000 gal per minute at the mines and even higher at recovery plants. For the most part, the required water is obtained from wells in the Floridan aquifer (Canterbury 1978). Generally speaking, companies engaged in phosphate mining also are engaged in beneficiation.

After beneficiation, phosphate rock generally holds 7% to 70% moisture content. At this stage, the product is termed "wet rock." Because some contracts require a product that does not exceed 3% moisture content, rock drying is a major operation. Once dried, the pulverized rock may be shipped directly to the customer for acidulation, or applied directly to the soil as fertilizer. Some phosphate rock is subjected to high temperatures to destroy the organic materials. This rock is called calcined phosphate.

Important products produced by the phosphate industry are sulfuric acid, phosphoric acid slag, ferrophosphorus, triple superphosphate, ammonium phosphates, superphosphate, superphosphoric acid, elemental phosphorus, and animal feed grade phosphate.

The transport of phosphate is dependent on rail lines and ports in the Bone Valley area. Trains usually originate at the Tampa Ports with empty cars transported to Bone Valley for loading. Products for export make the return trip to Tampa or other Florida ports. Phosphate products bound for other states move through Plant City, east of Tampa (Wilbur Smith and Associates 1980). The port facilities serving the phosphate industry in Southwest Florida are the Ports of Tampa and Port Manatee. The Port of Tampa has six marine loading terminals for rail shipments of phosphate rock and chemicals. Port Manatee, about 25 miles down channel from Tampa, has one phosphate terminal operated by Manatee Terminals, Inc.

About 40 million tons of rock were produced in 1978 by the phosphate industry in central Florida. Twenty-five million tons of rock were shipped to gulf coast ports. Most of the phosphate is loaded and shipped at the Port of Tampa, relatively small amounts are shipped from Boca Grande (Lee County) and Port Manatee (Wilbur Smith and Associates 1980).

Hillsborough, Manatee, and DeSoto counties support a variety of phosphate production operations including mining, processing, manufacturing, and marketing. Since 1967, the marketing patterns in Florida have consisted of (1) domestic shipments of dry phosphate rock to the upper gulf coast; (2) dry phosphate rock shipments along the Atlantic seaports; and (3) dry phosphate rock exported from the country (Canterbury 1978).

Table 1. New or anticipated phosphate mines in Southwest Florida in 1982-84 (Wilbur Smith and Associates 1980).

Name of Mine	County	Status[a]	Estimated production (million tons)	Mine life (years)	Start up (year)[b]
W. R. Grace Four Corners	Hillsborough and Manatee	C	3.3	25	1982
Swift agriculture	Manatee	D	3.0	21	1982
Beker phosphate	Manatee	D	3.5	18	1982
AMAX chemical	Manatee and DeSoto	D, P	4.0	28	1984
Total production			13.8		

[a] Development Planning (D), Permitting (P), Construction (C).
[b] Announced start up data by developer; actual start up will depend on the market and permitting process.

PHOSPHATE USES

Phosphate has many uses, but fertilizer is by far the most important. In 1975, the manufacture of fertilizer used about 80% of the phosphate rock used domestically. Other uses are leavening agents, water softening products, cleaning products, plasticizers, insecticides, beverages, ceramics, catalysts for oil refining processes, and dental cements. The production of different phosphate uses in 1975 are summarized in Table 2 (U.S. Environmental Protection Agency 1978).

Chemical plants located in the Bone Valley area process approximately 75% of the rock mined into elemental phosphorous, phosphoric acid and finished products. The remaining 25% is exported, usually as dry rock, to processing plants in other states or to foreign countries (U.S. Environmental Protection Agency 1978).

Table 2. Major phosphate products in 1975.

Product	Metric tons (in thousands)	Short tons (in thousands)
Fertilizer	24,484	26,995
Detergents	2,913	3,212
Animal feeds	1,396	1,539
Food products	248	273
Other	1,985	2,188
Total	31,026	34,207

ECONOMIC IMPACT

The Florida Phosphate Council in 1976 estimated that the phosphate mineral industry employed 8,837 people. Their payroll was over $119 million and average earnings were $13,494. In 1976, the phosphate industry contributed over $8 million in county and valorem revenues for the 5-county Bone Valley area. School taxes paid in the same area for 1975 were over $3 million. On a national level, the industry contributes to the improvement of the nation's balance of trade; about one-fourth of the rock mined in the area is exported (U.S. Environmental Protection Agency 1978).

The phosphate industry is a major component of the region's and State's economy. The U.S. Bureau of Mines made the following estimates in 1974 (U.S. Environmental Protection Agency 1978):

> Each new job in the phosphate industry generates six other new jobs.

Each dollar of income earned in the phosphate industry generates $3.36 of other income.

Each new dollar earned by the phosphate industry will generate $3.8 of other economic activity.

PROJECTIONS

Growth of the phosphate industry is determined largely by the demand for agricultural fertilizers. The demand for fertilizer is influenced by crop demand, water availability, pricing, weather, and Government regulation. The dynamics of these relationships make growth projections difficult.

In 1978, a comprehensive evaluation of the phosphate deposits of Florida using the "minerals availability system" was conducted for the U.S. Department of the Interior, Bureau of Mines. A conclusion of that study is as follows:

> The total Florida capacity can be made available to meet a total projected demand increase of 3% per year for the next twenty-five years if the deposits become environmentally, technologically, and economically viable... at that time (about 2002) capacity demand for Florida would exceed one hundred million tons annually. The identified deposits, although falling short of capacity demand at that level, would contain sufficient resources to continue production for an extended period at a high rate of production.

Notwithstanding the availability of the phosphate resource and market demand, water availability and energy costs will probably represent the most significant factors regarding future phosphate production.

OIL AND GAS EXPLORATION AND PRODUCTION

HISTORY OF OIL PROSPECTING

Oil prospecting in Florida began at the turn of the century and continued sporadically until the early 1940's when the State's first oil discovery was made in Collier County (Florida Geological Survey 1953). The well drilled at Sunniland by Humble Oil and Refining Co. began producing in 1943 and produced 20,550 barrels (bbl) of crude oil before being abandoned in 1946. A small oil field has been developed at Sunniland since then and continues to produce (Gunter 1952; Vernon and Henry 1961). In 1943-77, 161 onshore wildcat wells (wells drilled where oil fields have not been established) were drilled in the Sunniland formation of the South Florida basin. Ten oil fields were discovered of which 7 were located in Southwest Florida (Figure 4). Six oil fields in Collier and Lee Counties are currently producing oil and gas. The Sunniland Field, located in Collier County, has the highest production. In 35 years, this field has produced about 31% of the crude oil extracted in Southwest Florida. In 1977, 12 producing wells yielded an average of about 112 barrels per day (bbl/d) each. The field originally contained an estimated 37.6 million barrels of recoverable reserves; 17 million barrels were produced by 1979. Only a small part of the oil reserve is gas (oil-gas ratios are about 100 to 1; Babcock 1964).

Figure 4. Producing and plugged oil and gas fields in Florida (Curry and Tootle 1980).

Offshore oil exploration in Florida was recorded as early as 1947 when the first offshore well was drilled from an artifically created island about 48 km (30 miles) east of Key West. In 1947-53, offshore oil exploration continued in Federal and State waters under nominal Federal and State regulation. In 1953, Congress enacted The Outer Continental Shelf Lands Act (67 Stat. 462; 43 USC 1331-1343 ca. 1981) affirming that Federal submerged OCS lands, seaward of state boundaries would be subject to Federal Government control. On the west coast of Florida, State jurisdiction extends three marine leagues (approximately 17 km or 10.4 miles) from the coastline. The act governed the leasing of offshore tracts for exploration, development, and production of subsea minerals. The act provided that the Secretary of the Interior "...is authorized to grant to the highest responsible qualified bidder by competitive bidding under regulations promulgated in advance, oil and gas leases on submerged lands of the Outer Continental Shelf."

In 1959, the first Federal Lease Sale (L.S.#5) in Florida encompassed the Marquesas areas in the Straits of Florida between the Dry Tortugas and Key West. The sale offered 80 tracts (458,000 acres) of which 23 tracts were leased. Drilling was discontinued in 1963 because of the scarcity of oil.

In the early 1970's, the Federal Government began to open "frontier areas" (areas where OCS activities have never taken place) in response to the national policy to accelerate oil and gas production in the United States. One such frontier area was designated in the Eastern Gulf of Mexico adjacent to the States of Mississippi, Alabama and Florida (MAFLA). Following a lengthy leasing process, 62 tracts representing 196,516 ha (485,396 acres) were sold under Lease Sale #32 in 1973. The so-called MAFLA area had most of its tracts adjacent to Florida (U.S. Department of the Interior 1980a). Bids received by the U.S. Department of the Interior exceeded $1 billion, which was the largest sum ever realized from a lease sale. The large bids reflected the industry's optimism at that time for an oil or gas find in the MAFLA area. Drilling permits were issued for 43 of the 62 tracts; 14 of these were actually drilled, but all were reported by the industry to be dry (U.S. Department of the Interior 1980).

A second MAFLA sale was made in 1976. Thirty-four of the 132 tracts offered that were sold consisted of 65,297 ha (161,285 acres). Four tracts leased adjacent to Florida were purchased by a consortium of oil companies, but in 1981, only one drilling permit had been issued and apparently no discoveries were made.

The third MAFLA sale (L.S. #65) in 1978 leased 35 tracts consisting of 81,495 ha (201,294 acres). It was the first lease sale adjacent to Florida in the Gulf of Mexico subject to the Outer Continental Shelf Lands Amendments of 1978 (43 U.S.C. 1351). By April 1981, ten environmental reports and exploration plans had been filed with the Federal Government of which eight were approved for drilling. No discoveries have been made on the four tracts under exploration.

Other lease sales in the MAFLA area offered tracts adjacent to other States as well as in Florida (Figure 5). Florida's share (40%) of lease sales, in comparison with that for the entire MAFLA area, is given in Tables 3 and 4.

Table 3. Lease sales in 1959, 1973, 1976, and 1978 in the gulf waters of Mississippi, Alabama, and Florida combined (U.S. Department of the Interior 1980a).

Lease sale number	Date	Tracts offered for lease		Tracts leased		Percent of offered tracts leased	
		Florida	MAFLA	Florida	MAFLA	Florida	MAFLA
05[a]	2/26/59	80	0	23	0	29	0
32	12/20/73	85	147	62	87	67	59
41	2/18/76	60	132	4	34	7	26
65	10/28/78	71	89	28	35	39	39
Total		296	368	117	156		

[a]L.S. #5 is not considered part of MAFLA, but all leasing was in waters adjacent to Florida.

Table 4. Lease sales (acres) offered and leased in 1959, 1973, 1976, and 1978 for Florida, Mississippi, Alabama, and Florida combined (U.S. Department of the Interior 1980a).

Lease sale number	Date	Acres offered		Acres leased		Percent of offered acres leased	
		Florida	MAFLA	Florida	MAFLA	Florida	MAFLA
05[a]	2/26/59	458,000		32,480		7	
32	12/20/73	489,600	817,297	357,120	485,396	73	59
41	2/18/76	350,292	687,603	23,040	161,285	7	23
65	10/28/78	408,334	511,709	161,280	201,294	39	39
Total		1,706,226	2,474,609	673,920	980,455		

[a] L.S. #5 is not considered part of MAFLA, but all leasing was in waters adjacent to Florida.

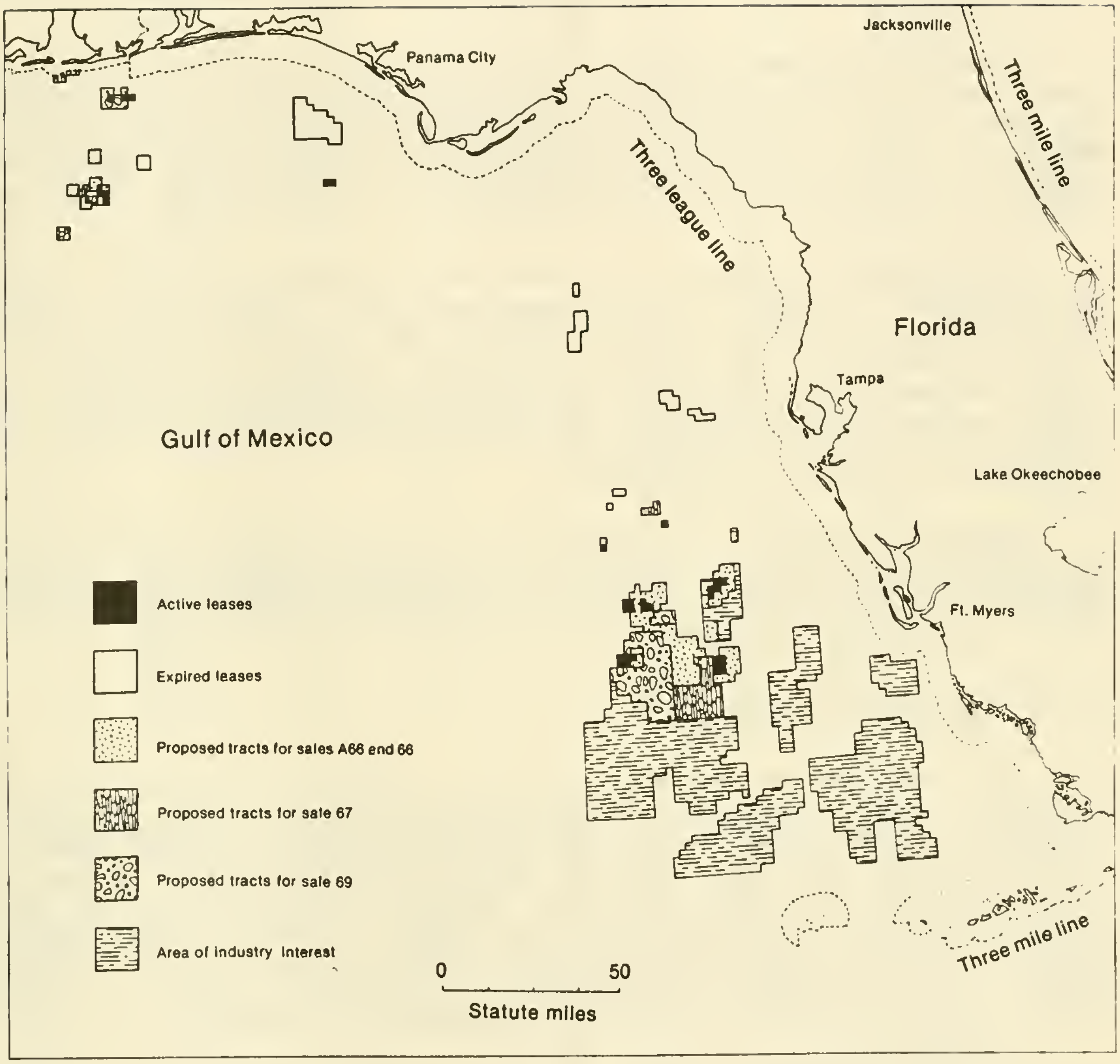

Figure 5. Status of OCS lease areas off the Florida gulf coast (U. S. Department of the Interior, Bureau of Land Managemenr 1980; Southwest Florida Regional Planning Council 1981).

PETROLEUM PRODUCTION

Onshore petroleum production in Southwest Florida is confined largely to Collier and Lee Counites. Oil and gas are produced in the Sunniland, West Felda, Lake Trafford, Bear Island, Leheigh Park, and Baxter Island fields. In 1979, these fields yielded 4,304,333 bbl of crude oil and 353,000 million cubic feet (MCF) of gas.

The 1943 Sunniland discovery in Collier County was followed by the Lee County West Felda field in 1966 and the Lake Trafford field in Collier County. The Bear Island field in Collier County began production in 1972, and the Leheigh Park field in Lee County began production in 1974. Table 5 gives estimated oil and gas reserves, 1979 production, and cumulative production in Southwest Florida.

The Sunniland field, the most productive and largest producing field, has 37,685,118 bbl in reserve, and produces about 33% of the crude oil in Southwest Florida. The West Felda field was the greatest producer in 1979 (2,176,321 barrels or 51% of the total crude oil production in Southwest Florida). The West Felda field has a reserve of 142,857,143 bbl. The West Felda field produces the most natural gas; it has 11,428,571 MCF in reserves. Production in 1975 was 162,428 MCF which was about 67% and 46% of the region's reserves and production, respectively.

Oil and gas production in Southwest Florida was valued at $42 million for 1978 based on $9.23/bbl for crude oil and $0.35/MCF for gas. This income is about 6% of the State's total value of crude oil, natural gas liquids, and natural gas for the same year.

OCS OIL AND GAS PROJECTIONS

USGS long-term oil and gas production forecasts for the Gulf of Mexico indicate a gradual decline in production and an ultimate depletion sometime soon after. Since production is not independent of technological innovation, economics and market forces, recovery in old, nearly depleted wells from steam injections could increase recoverable reserves in existing fields. Breakthroughs in oil platform design enabling cheaper and smaller production units could allow small, currently uneconomical fields to become economical for production. As the complex relationships of technology, economics and market forces change, estimates of recoverable resources also change.

The Resource Appraisal Group (RAG) of USGS assessed undiscovered recoverable oil and gas resources and developed the production curves shown in Figure 6. The RAG and the Office of Resource Analysis (also in USGS) use occurrence modeling, search modeling, and production modeling.

Data obtained from research are being used to develop a sophisticated model on the dynamics of petroleum reserves. The Clark-Drew Model is capable of determining (1) the field size distribution of total resources, (2) field size distribution of deposits discoverable at different levels of cost and technology, and (3) production curves over time using various socioeconomic assumptions (U.S. Department of the Interior 1980).

Table 5. Oil and gas reserves and production in the major fields in Southwest Florida in 1979 (U.S. Department of the Interior 1980a).

Field	Oil (bbl)			Gas (MCF)		
	Reserves	Production	Accumulated production	Reserves	Production	Accumulated production
Baxter	480,714	--	1,859	--	--	--
Bear Island	17,874,432	106,161	4,057,533	1,429,955	84,912	306,325
Lake Trafford	1,792,098	13,880	179,439	--	--	--
West Felda	142,857,143	2,176,321	28,924,408	11,423,571	162,428	2,036,482
Leheigh Park	3,610,996	664,285	2,275,879	361,099	67,328	230,243
Sunniland	37,685,118	383,016	17,151,182	3,768,512	38,336	397,171
Southwest Florida Totals	204,300,501	3,344,663	52,590,300	16,983,137	353,004	2,970,221
Statewide Totals	1,120,525,179[a]	49,811,599	277,436,328	1,082,608,605[a]	54,162,641	337,881,773
Percentage in Southwest Florida	18.2	8.6	18.9	1.6	0.7	0.9

[a] Statewide totals for oil and gas reserves are for 1978.

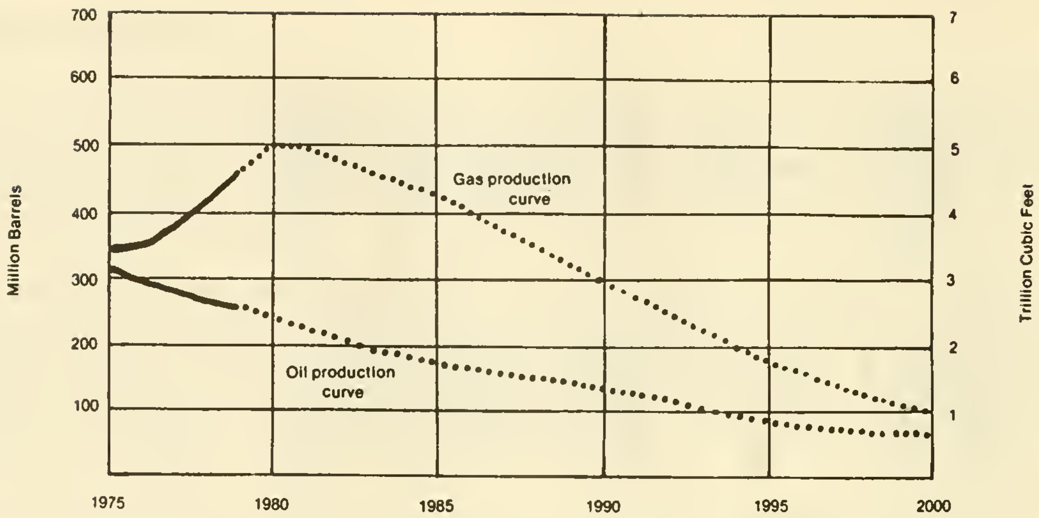

Figure 6. Projected oil and gas production for the Gulf of Mexico from 1975 to 2000 (U.S. Department of the Interior 1980a, 1980b).

The Clark-Drew Model indicates that there are over 1,000 oil fields or reservoirs yet to be discovered in the Gulf of Mexico. Half of them would likely be small, perhaps each containing less than one million barrels of recoverable oil. Under suitable market conditions and technological innovations, these fields could be profitably brought into production. Oil and gas produced from these fields would not greatly increase, but the date of ultimate depletion would be extended. There are no published estimates of oil and gas reserves in the eastern Gulf of Mexico.

RESOURCE AND RESERVE ESTIMATES

To determine OCS oil and gas reserves, the USGS conducts geophysical studies, reviews data gathered by oil and gas companies under pre-lease exploratory permits, and examines the exploration and development of existing OCS oil and gas exploratory and production activities.

The most recent estimates of oil and gas reserves were made by USGS. These estimates are based on undiscovered recoverable oil and gas in 1980 and known remaining recoverable reserves in January 1979 (Table 6).

Recoverable reserves is the amount of oil and gas in a given field before exploration, development, and production. The original recoverable reserves in the Gulf of Mexico were estimated by USGS to have been 7.52 billion barrels of oil and 76.2 trillion ft^3 of gas. More than three decades of production yielded 4.76 billion bbl of oil and 39 trillion ft^3 of gas (U.S. Department of the Interior 1980b). The most recent undiscovered recoverable reserve estimates for the Gulf of Mexico are 6.5 billion bbl of oil and 71.9 trillion ft^3 of gas.

Table 6. Oil and gas recoverable reserves in the Gulf of Mexico in 1979 as predicted by USGS, U.S. Department of the Interior (1980a).

Location	Oil (billion bbl)[a]	Gas (trillion ft^3)
Western Gulf of Mexico (Main pass area and west) 0-2,500 m water depth	5.2	69.0
Eastern Gulf of Mexico (East of main pass area) 0-2,500 m water depth	1.3	2.9
Known reserves	2.8	37.2

[a] bbl = barrel = 42 U.S. gallons.

According to the 5-year OCS oil and gas leasing schedule of June 1980, one lease sale in the eastern gulf is scheduled for October 1981. Tracts for lease sales gulfwide may include Florida waters (Lease Sale No. A66, July 1981; 67, March 1982; 69, August 1982).

OCS OIL AND GAS EXTRACTION FACILITIES

Exploration, development, and production of oil and gas resources on the Outer Continental Shelf (OCS) involves a variety of onshore facilities. Generally in frontier areas like the eastern gulf, OCS oil and gas explorations are performed by an imported specialized industrial group. A profitable find would require facilities in a nearby coastal area. The economic requirements for certain types of OCS onshore facilities (e.g., refineries, processing plants, and fabrication yards) are such that in many cases, a high level of oil and gas production is necessary to support new or sizable onshore facilities and services. In the case of marginal production or profit from production, the offshore operations probably would be serviced by existing facilities in Texas or Louisiana.

PHASES OF OCS OIL AND GAS PRODUCTION

The six phases of OCS activities are: (1) tract selection, (2) leasing, (3) exploration, (4) development, (5) production, and (6) shut down. These phases may span a period of 15 to 40 years, but there is a considerable overlap. With the exception of geophysical and geological exploration vessels that locate oil and gas bearing geological formations, there is little business for onshore facilities or services during the leasing phase.

The exploration phase usually lasts from 1 to 7 years (New England River Basins Commission 1976a). Temporary service bases are established, generally locating in existing ports to serve and support exploratory drilling. Exploratory drilling is conducted from a jack-up platform, semi-submersible platform, drill ships, or barges. Limited onshore support activities are required during the exploration phase and most of this activity is temporary, often operating on leased space. One of the most important onshore activities during exploration is support from service bases and from suppliers of tubular goods and drilling muds and cement.

The development phase lasts from 4 to 9 years (New England River Basins Commission 1976a) after which oil and gas are produced commercially. Development drilling is usually performed from fixed platforms that are floated to the site and position on the ocean floor. Onshore activities peak during the development phase. Permanent service bases are established, oil/gas transportation systems are implemented, and a diverse assortment of industries (such as tool and equipment companies, catering services, repair and maintenance yards, diving companies, and specialized drilling equipment companies) locate onshore.

As well drilling is completed, the production phase begins. This phase lasts 10 to 25 years or more. During this phase, the drilling is disassembled and production equipment is installed. Oil may be pumped ashore by pipeline or pumped directly into tankers. Volume production and demand will dictate whether OCS oil and gas production near Florida will be refined in Florida or trans-shipped out of the State. Gas must be piped to shore for processing and treatment facilities, but a gas processing plant may be constructed inland between the OCS pipeline landfall and the existing gas infrastructure (distribution system).

During shutdown in a field, onshore facilities and operations would close or shift to other uses.

LOCATION FACTORS FOR ONSHORE FACILITIES

Proximity to offshore OCS activities is generally the most important factor in determining the location of onshore facilities. Another important consideration is the tendency for OCS support activities to aggregate, or locate in a central geographical area, usually in a port area. The tendency to cluster near other related industries would meet the need for cooperation and interaction among the support activities. Economic efficiency may be achieved by minimizing the duplication of facilities and equipment.

A number and diverse assortment of onshore support facilities are required to support offshore OCS operations. Some of the major factors affecting the number and location of these facilities are listed below (New England River Basins Commission 1976b).

Location of oil and gas field
Size of oil and gas field
Topography of oil and gas field
Depth of water

Whether both oil and gas are found
Availability of coastal frontage (land)
Availability of additional (back-up) land
Proximity to existing refineries and processing plants
Proximity to diverse urban areas and markets
Public services and facilities (schools, hospitals)
Labor markets (areas without strong labor unions are preferred)
Public opinion
Availability of entertainment
Proximity to airport or landing strip

FACILITY REQUIREMENTS

This section describes typical onshore OCS facilities. Facility requirements, siting considerations, and impacts.

Service bases

Service bases provide transportation, services, and storage for drilling equipment, supplies, personnel, and other necessities to and from OCS oil and gas rigs and platforms. Transportation to offshore operations usually depends upon supply boats for equipment and materials and crewboats and helicopters for personnel. Usually at least two supply boats, one crew boat, and one helicopter are necessary to support each drilling rig or platform. Where drilling is located far offshore, more vessels and helicopters may be needed because of excessive travel time. Transportation onshore is by rail, road, air, and water.

Service bases require at least two berths, each about 122 m (400 ft) long, per rig. Fewer vessels and helicopters may be required if several rigs are serviced from the same service base. Depending on the distance to the rig and the nature of offshore OCS operations, at least two vessel trips and one helicopter trip per rig are required daily. The typical types and quantities of materials transported offshore to a drilling rig in one year are shown in Table 7.

Table 7. Types and quantities of materials transported annually offshore to an exploration rig (New England River Basins Commission 1976b).

Materials	
Type	Quantity
Fuel	10,000-15,000 bbl
Drilling mud	2,000-5,000 tons
Cement	1,000-3,000 tons
Fresh water	5,000,000-7,500,000 gal
Tubular goods	2,000-3,000 tons

Temporary service bases are established as soon as exploration and early development begins. Temporary bases may be expanded into permanent service bases but only after a significant discovery of oil or gas has been made. Pipeline installation service bases locate during the latter part of the development phase; preferred locations are the pipeline landfall sites and supporting pipe casting yards. Preferred locations for platform installation service bases are sites nearest to the platforms.

In addition to the general factors affecting location, service bases usually have specific siting considerations and impacts (Table 8).

Transportation facilities

Pipelines usually are the preferred method of transporting oil from offshore to onshore locations (sometimes tankers are used). Gas is always transported by pipeline. The locations of pipelines usually depend upon decisions based on distance from shore (the shorter the better), and environmental considerations, e.g., ocean bottoms and landfall beaches. The location, costs, and suitability of pipeline easements also are important considerations. Usually the production threshold that must be met to justify the construction of a pipeline is 70,000 bbl/d for oil and 500 million ft^3/d for gas.

Pipeline construction and operations require a number of onshore support facilities including pipe coating yards, service bases, testing and inspection services, diving companies, and survey teams. Pumping stations are sometimes required and, depending on the final destination of the oil or gas, a refinery, processing plant, marine terminal, or storage facilities may become necessary. Siting considerations and impacts of facilities directly associated with pipelines are listed in Table 9.

Marine terminal facilities

In Florida, marine terminals will most likely receive crude oil from offshore locations via pipelines during the major portion of the production phase, although small tankers (16,000-25,000 deadweight tons) may be used until pipelines are constructed. Until quantities of gas are found to be large enough for production, gas is either flared or reinjected into the reservoir.

Terminal facilities vary depending on the particular needs and the availability of waterfront or backup land. Berthing facilities may include offshore moorings, fixed island piers, fixed shoreside piers, floating T-piers, or other methods. Site considerations and impacts associated with terminals and product storage are presented in Table 10.

Processing and treatment facilities

Crude oil produced at the wellhead requires processing to separate oil, natural gas, brine, water, and suspended and dissolved solids. The processing takes place at the well site, onshore, or both. The nature and location of facilities that will be used to separate these ingredients from the wellstream depend on the characteristics of the ingredients and transportation.

Table 8. Siting considerations and potential pollutants from OCS and gas development and onshore service bases (Adapted from New England River Basins Commission 1976b).

Categories or elements		Economic requirements/pollutants
Siting considerations		
Land	Temporary base	2-6 ha (5-15 acres)
	Permanent base	10-40 ha (25-100 acres)
Berthage		61-183 m (200-600 ft) water frontage 5-6 m (15-20 ft) water depth
Transportation		Air-heliport very close proximity Water-excellent vessel accessibility Rail-desirable Road-adequate accessibility
Economic		Cost of land Proximity to related industries
Economic base		
Labor		50-60 jobs/platform during drilling 20-30 jobs/platform during production
Wages		$750,000-$1,000,000/year
Capital investment		Temporary base - $200,000-$300,000 Permanent base - $2 million-$5 million
Type of pollution		
Air emission		Hydrocarbons Carbon monoxide Nitrogen oxides
Wastewater contaminants		Hydrocarbons Heavy metals
Solid wastes		Up to 6 tons/d during drilling Hazardous wastes
Noise		Up to 100 dBA on a 24-hour basis (measure of the intensity of sound)

Table 9. Siting considerations and potential pollutants from pipeline facilities (New England River Basins Commission 1976b).

Categories or elements		Economic requirements/pollutants
Siting considerations		
Land	Pipeline easement (on shore)	15-30 m (50-100 ft)
	Pipecoating yard	20-61 ha (50-150 acres)
	Pumping station (if required)	16 ha (40 acres)
Waterfront		15-30 m (50-100 ft) for landfall 229 m (750 ft) for pipe coating yard (water depth at least 3 m or 10 ft)
Water		11,350-56,775 l/d (3,000-15,000 gal/d)
Economic base		
Labor		250-300 jobs/pipeline during construction 100-200 jobs at pipecoating yard during pipeline construction
Wages		$5 million-$6 million/year for pipeline construction $1.5 million-$3 million for pipe-coating yard during construction
Capital investment		$8 million-$10 million for pipecoating yard
Type of pollution		
Air emission		Hydrocarbons Sulfur oxides Nitrogen oxides Particulates Carbon monoxide
Wastewater contaminants		Alkaline substances Hydrocarbons Particulates Metal fragments
Solid wastes		Concrete Contaminated debris Packaging materials Metal scraps
Noise		Up to 100 dBA on a 24-hour basis (measure of the intensity of sound)

Table 10. Siting considerations and potential pollution from berthing facilities (Adapted from New England River Basins Commission 1976b).

Categories or elements	Economic requirements/pollutants
<u>Siting considerations</u>	
Land	
Terminal	20-30 ha (50-75 acres)
Tank farm	8-30 ha (20-75 acres)
Berthage	Approximately 304 m (1,000 ft) for pier
Water	Potable water Purging
<u>Economic base</u>	
Labor	25-75 jobs
Wages	$500,000-$1,000,000/year
Capital investment	$15-$50 million
<u>Pollution sources</u>	
Air emissions	Hydrocarbons Carbon monoxide
Wastewater contaminants	Oil and grease High BOD (Biochemical oxygen demand) High COD (Chemical oxygen demand)

The first step is to remove impurities and separate gas and, in some cases, water from the wellstream. Gas found in a free state with little or no oil present is termed non-associated gas. Non-associated gas may be reinjected or piped inland for sale. Associated gas (which is found in solution with oil), if found in large enough quantities to justify the construction of a pipeline, is transported ashore for further processing and to recover liquifiable hydrocarbons.

In some cases the entire wellstream is piped ashore. There is a tradeoff here, however, between using the larger pipe size needed to carry the increased volume (because of free water) versus the use of valuable platform space for water separators. Emulsified water is usually separated out of the wellstream onshore because equipment necessary for this process is relatively complex. Both free and emulsified water must be treated before discharge. The siting considerations and impacts of onshore processing and treatment facilities are shown in Table 11.

Table 11. Siting considerations and potential pollutants from onshore processing and treatment facilities (Adapted from New England River Basins Commission 1976b).

Categories or elements	Economic requirements/pollutants
<u>Siting considerations</u>	
Land	20-30 ha (50-75 acres)
Water	200-750,000 gal/d
<u>Economic base</u>	
Labor	50-60 jobs
Wages	$750,000-$1,000,000/year
Capital investment	$50-100 million
<u>Pollution sources</u>	
Air emissions	Carbon monoxide Hydrocarbons Hydrogen sulfides Nitrogen oxides Particulates Sulfur oxides
Wastewater contaminants	Oil and grease Heavy metals Phenols Halogens Chromium Sulfuric acid Phosphates Chlorine Zinc
Noise	Up to 100 dBA on a 24-hour basis (measure of the intensity of sound)
Solid wastes	Scale and sludge Oil absorbants Spent desiccants

Refineries

A modern oil refinery physically or chemically alters all or part of crude oil to produce a number of petroleum products. The three major types of refineries are market refineries built to serve a particular market, resource refineries built on or near major oil fields, and swing refineries built to balance supply and demand. The market refinery is the preferred type of refinery because shipping bulk crude oil is less costly than shipping several refined products. Refineries are not usually constructed to accommodate OCS production areas unless a relatively large demand is located nearby.

Refineries usually are complexes that include storage tanks, administration and maintenance facilities, water treatment facilities, and laboratories. The entire complex is usually surrounded by a buffer zone. Transportation systems including rail, road, pipelines, and marine terminals also are required. Site considerations and impacts associated with oil refineries are given in Table 12.

Table 12. Siting considerations and potential sources of pollution from oil refineries (Adapted from New England River Basins Commission 1976b).

Categories or elements	Economic requirements/pollutants
Siting considerations	
Land	202-809 ha (500-2,000 acres)
Water	5-10 million gal/d
Economic base	
Labor	200-600 jobs
Wages	$6-$10 million/year
Capital investment	$5-$250 million
Type of pollution	
Air emissions	Ammonia Aldehydes Carbon monoxide Hydrocarbons Particulates Sulfur oxides
Wastewater contaminants	Acids and caustics Floating and dissolved oil Dissolved solids Dissolved organics Cyanide Chromate

Platform fabrication yards

Offshore OCS oil and gas drilling and production are conducted from platforms that are constructed of steel or concrete. The main body, or jacket, supporting the platforms is constructed almost entirely of tubular steel that is fabricated onshore at a waterfront location, placed in the water and towed to the installation site, and set in place on the ocean floor. Decks, drilling rig, living quarters, and other rig components also are constructed onshore and towed to an offshore site. Several types of platforms are constructed depending upon depth, sea bottom type, weather trends, the mix and type of oil and gas in the find, and other factors.

Platform fabrication yards are large marine facilities usually consisting of fabrication shops, welding racks, pipe mills, concrete mixing plants, and cement storage silos (if concrete platforms are used), and administrative facilities (Table 13).

Table 13. Siting conditions and potential sources of pollution from platform fabrication yards (Adapted from New England River Basins Commission 1976b).

Categories or elements	Economic requirements/pollutants
Site considerations	
Land	10-324 ha (25-800 acres)
Berthage	61-122 m (200-400 ft) 5-15 m (15-50 ft) depth
Water	10,000-100,000 gal/d
Type of pollution	
Air emissions	Sand and metal dust Concrete and cement dust Nitrogen oxide Sulfur oxide Hydrocarbons Organic compounds
Wastewater contaminants	Heavy metals Chemicals Particulates
Noise	Up to 100 dBA on a 24-hour basis (measure of the intensity of sound)

Phosphate clearly is the predominant mineral in Southwest Florida, but data on the amounts and value of production are not available in publicly available documents. Although production is high in Polk, Hillsborough, and Hardee Counties, there has been recent speculation that significant quantities of phosphate may exist in the continental shelf of the Gulf of Mexico, approximately 16 to 96 km (10 to 60 miles) off the coast from Clearwater.

Other minerals of importance to Southwest Florida are peat, limestone, cement, and sand, but none are as important as oil and phosphate. One mineral which is gaining importance as a by-product of phosphate production is uranium.

Southwest Florida is the Nation's leading producer of phosphate and has the potential for major OCS oil production; consequently, it is important to know the current and potential value and magnitude of production of both minerals. Nondisclosure rules, however, make it virtually impossible to obtain reliable information on a county-by-county basis. The information that is available on employment in mineral industries in Southwest Florida is grouped in size ranges (e.g., 0-19, 20-99 employees, etc.) by the Bureau of Census. Consequently, employment data on mineral industries are of little use when evaluating the economic significance of the mineral industry. Other information on mineral industries is similarly limited.

The information required above cannot be obtained from the Bureau of Census because of nondisclosure rules. If information on minerals production by county is needed, it will have to be obtained in a way that will avoid disclosure, if possible.

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RECREATION AND TOURISM

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INTRODUCTION

The purpose of this paper is to synthesize data on outdoor recreation and tourism in Charlotte, Collier, DeSota, Hillsborough, Lee, Manatee, Monroe, Pasco, Pinellas, and Sarasota Counties in Southwest Florida. The data and analyses will be used to help assess the potential impacts of OCS oil and gas development on tourism and outdoor recreation.

Recreation is a major use characteristic of coastal Florida. According to the Natural Resources Defense Council (1976), coastal recreation per capita is 10 days annually. Sport fishing attracts millions of resident and out-of-state (tourist) saltwater anglers, and is a multimillion dollar a year business. Hunting, surfing, boating, skindiving, beach recreation, and nature studies are popular coastal activities. In recent decades the demand for recreation has been increasing, but opportunities have been declining. Only a small fraction of Florida's coastline is now available for public recreation and some of the finest and more accessible areas are being developed for other uses.

The rapid growth of population, urbanization, urban sprawl, the automobile, and new highways have created a crisis in the amount of land available for recreation. Each year, it becomes more expensive and more difficult to obtain new areas for playgrounds, parks, forests, wildlife management areas, and fish and wildlife preserves.

Water resources are in need of a comprehensive program of restoration and expansion. The problems caused by water pollution, sedimentation and dredge and fill operations, have reduced the value of coastal waters as recreation areas. As Floridians and tourists increase their mobility, disposable income, and leisure time, their demands for recreation and tourism also increase. The consequences are that many different interest groups are likely to compete for the use of a limited supply of resources.

Perhaps the most visible problem created by a rapidly shrinking natural coastline is that of public access to fishing grounds (Hinman 1978). Sewage disposal and silt-laden runoff from dredge and fill navigation projects usually increase turbidity and lead to deleterious effects on estuarine and nearshore fisheries. Most fisherman must venture farther offshore to less polluted water, which leads to a greater expenditure of time and money. Bell (1978) states that increasing population, higher real per capita incomes, shorter work weeks, and longer vacations mean more leisure time and money for outdoor recreation. The effect of increasing demand and dwindling supply will most certainly raise the real value of sport fishing. The terms sport fishing and recreational fishing are used interchangably in the literature; for continuity in this report, sport fishing, or sport fish, is used.

Since 1979, one of the major economic issues in Florida has been the tourist industry. Although tourism has been confronted with inflation and high energy costs, the industry is still strong and the natural resources that provide recreation for tourists must be protected.

STATE OF FLORIDA OVERVIEW

Compared to the Nation as a whole, the population growth of Florida over the past 30 years has been a dramatic one. The U.S. population grew 45% from 1950 to 1979, but Florida's population grew over 300% (2.7 million to 9.2 million). Part of Florida's increase was caused by the influx of retirees. The number of retirees in the population increased from 11% to 18% in 1960-79 (9% to 11% nationwide).

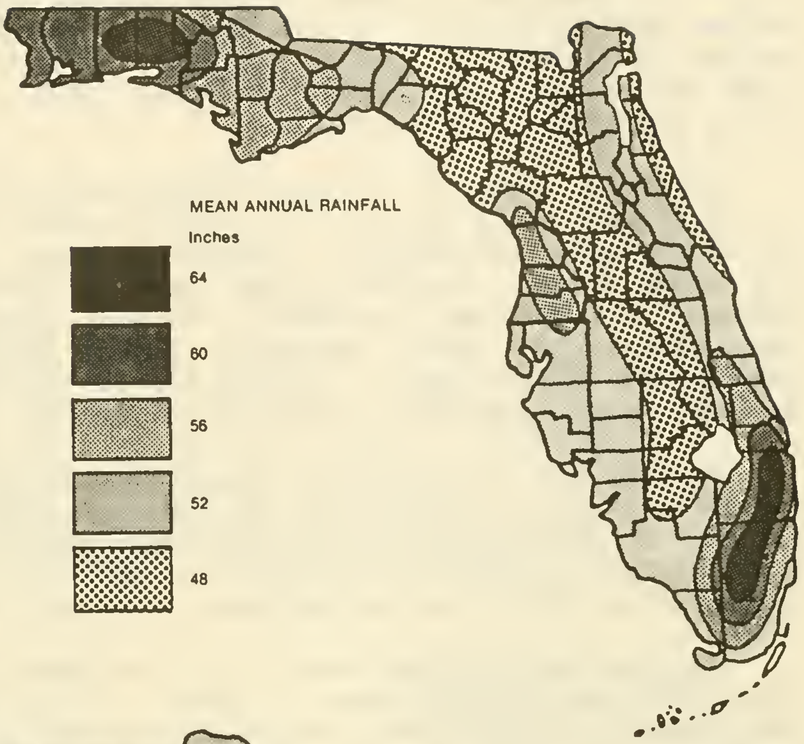
The population of Florida in 1980 was 9.7 million, a 43.7% increase since 1970. The average rate of increase was 3.7% per year (1980 U.S Census data from Florida State University computer tape). In the 1970's, Florida was the third fastest growing state in the country behind Nevada and Arizona. Despite the 1980 recession, tourism in Florida did not decline as it did in the recession in 1974-75. In 1974, there was a decline in out-of-state cars, but the number of tourist arrivals actually increased. As gasoline prices and the cost of air travel increase, combined with the slow growth in real income, tourism in Florida is likely to level off. The tourist predictions for 1981 are about 33.3 million, a 1.7% increase over 1980.

In 1989, Florida can expect over 48.4 million tourists. This is 15.3 million more visitors than in 1979. The annual projected tourist growth rate in 1979-89 is 3.9% compared to 6.6% for the previous decade.

The impacts of recreation and tourism on Florida's economy are reflected by the sales of nondurable goods. Sales of recreation related nondurable goods ($10 billion statewide) were 18% of total taxable sales in 1979. The 1989 forecast shows $30 billion or 18.72% of the State total. Recreation nondurable taxable sales in Florida were $2.7 billion in 1968, $3.4 billion in 1970, $5.8 billion in 1975, and $8.6 billion in 1978.

Florida has become the mecca for outdoor recreation seekers throughout the United States and it is rapidly becoming one of the most popular winter vacation spots for Europeans and other foreigners as well (Florida Department of Natural Resources 1981). Each year over 33 million tourists visit Florida to take part in outdoor recreation and as Florida's population grows, there will be a need for additional outdoor recreation services and facilities. Although residents in urban areas engage in user-oriented recreation more than resource-oriented recreation, urbanites are expected to make greater demand on resource-based recreation in the future, which will require further public purchase of the natural lands and waters.

Florida's climate is temperate in the northern part of the State to subtropical or tropical in the south. Year-round temperatures are suitable for outdoor recreation throughout the State (Figure 1). Florida has over 54,000 mi^2 of land area and 15,000 mi^2 of territorial waters and estuaries. Territorial waters make up 85% of the total and estuaries (bays, lagoons, and marshes) make up the other 15%.



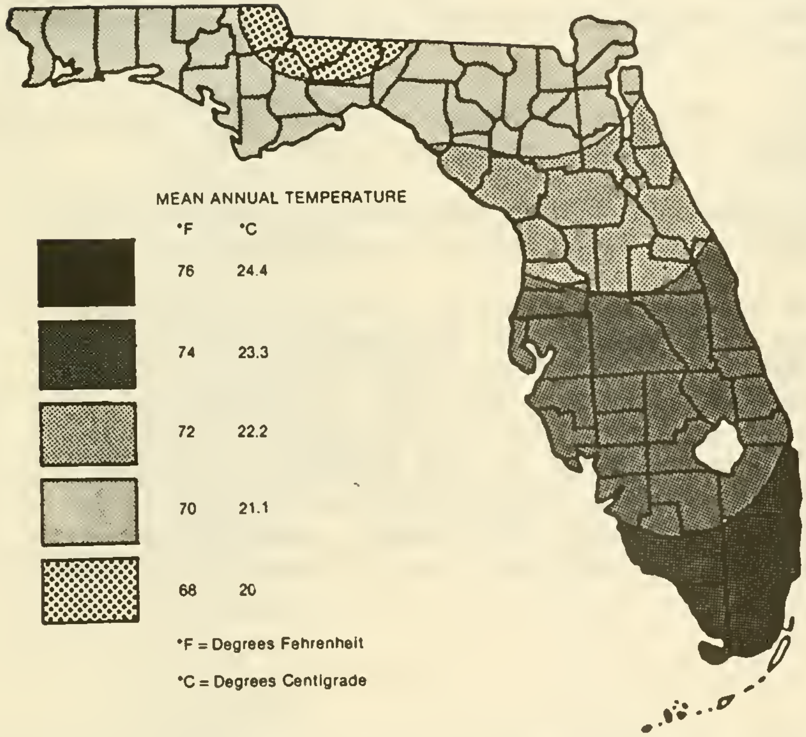


Figure 1. Mean annual rainfall and temperature in Florida (Wood and Fernald 1974).

Florida has a wealth of natural resources that support outdoor recreation. The State has 22 major natural springs that discharge over 3 billion gallons per day (Bgal/d) to form lakes and rivers. The combined flow of all springs in Florida is about 5 Bgal/d. Florida's 7,700 lakes comprise over 3,200 mi^2 of water area and it has about 1,700 rivers and streams that total nearly 12,000 miles in length.

Florida's coastline is about 11,000 miles long, much of which is comprised of high energy beaches. Florida's barrier islands provide a wide range of recreational opportunities including fishing, swimming, hunting, camping, and nature study, located in areas such as parks, natural areas, wildlife refuges, and national seashores. Barrier islands have numerous motels, restaurants, gift shops, amusement parks, marinas, golf courses, tennis courts, and swimming pools. Florida has 13 registered historic places and 7 national natural landmarks located on its barrier islands.

Florida has 173 (more or less, depending on how they are classified) recreation sites. This includes 30 preserves, forests, and State parks (Figure 2), 35 State aquatic preserves (Figure 3), 48 State wildlife management areas (Figure 4), and 32 special feature sites, 17 preserves, 7 museums, and 4 ornamental gardens (Florida Department of Natural Resources 1981).

The per capita expenditures of U.S. residents for hunting and fishing for 1955, 1960, and 1970 is shown in Table 1. These data will be used later in this report to help estimate the magnitude and value of the fishing and hunting industries in Southwest Florida.

The Governor's office (1980) has developed a set of goals and priorities for 1981-83. Those relating to outdoor recreation are as follows:

> Goal: to improve outdoor recreation opportunities through development and implementation of a new outdoor recreation plan.
>
> Policies: (1) The State shall continue acquisition and development of State parks with emphasis on high quality resources and public accessibility. (2) The State shall provide recreation programs, sites, and facilities that best meet public demand. (3) The State shall expand recreational opportunities to include user-oriented recreation, particularly in and around urban areas to provide convenient and energy conservative outdoor recreation. (4) The State shall emphasize inter-agency coordination and cooperation in providing improved and diversified outdoor recreation opportunities.

STATE PROGRAMS

The Florida Department of Natural Resources (DNR), Division of Recreation and Parks has the authority to acquire, develop, and operate State parks and recreation areas. The Division is responsible for administering a comprehensive recreation program. State funds from the Land and Water Conservation Funds are matched by Federal funds to purchase parks and recreation sites. The Division develops a State Outdoor Recreation Plan every 5 years and provides technical assistance on outdoor recreation to local governments through the

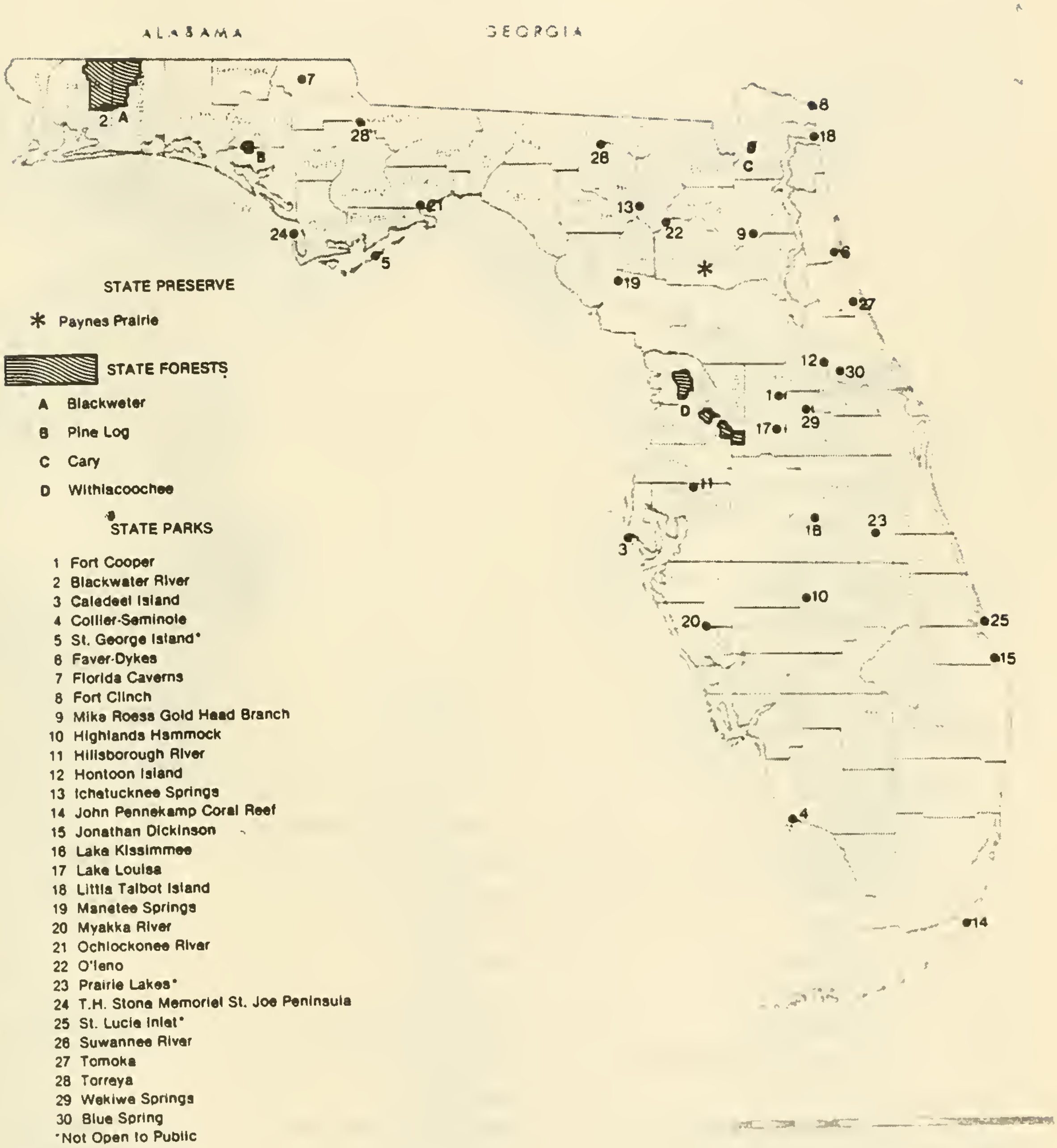


Figure 2. State preserves, forests and parks (Florida Power and Light Co. 1979).

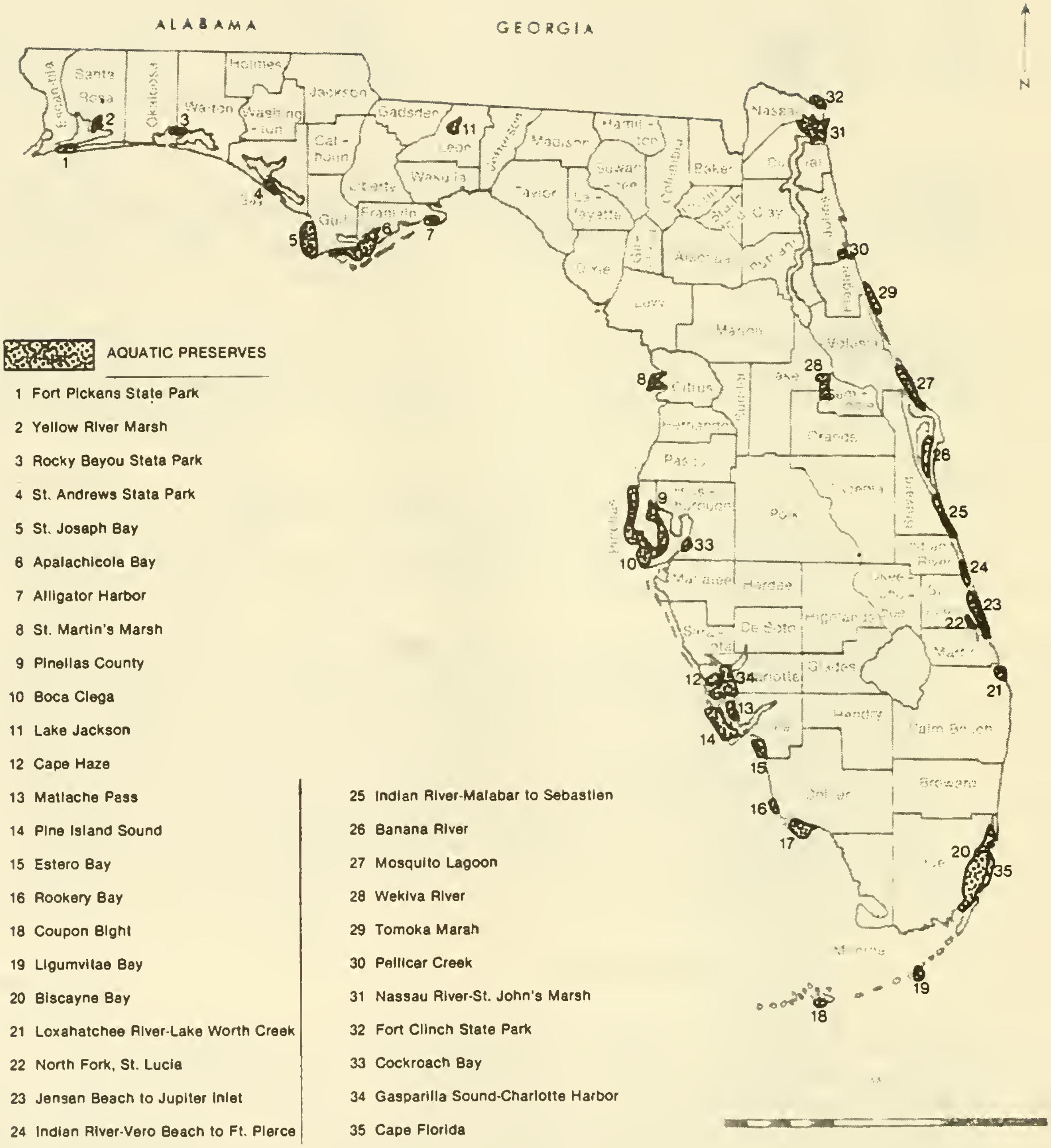


Figure 3. State Aquatic Preserves (Florida Power and Light Co. 1979).

Figure 4. State Wildlife Management Areas (Florida Power and Light Co. 1979).

Table 1. Per capita expenditures (in dollars) in the United States for fishing and hunting (Adapted from U.S. Department of Interior, Fish and Wildlife Service 1960, 1970).

Category	1955	1960	1970
Freshwater fishing	77	95	127.17
Saltwater fishing	91	101	178.10[a]
Waterfoul hunting	60	46	84.47
Small game hunting	50	60	81.02
Big game hunting	73	55	122.53

[a]Gulf of Mexico only.

Florida Recreation Development Assistance Program. The Florida DNR spent $483.85 million on parks and recreation in fiscal years 1971-72 through 1979-80 and increased the number of employees in park and recreation programs from 424 to 767 (Governor's Office of Planning and Budgeting 1981). The DNR Division of State Lands administers the Conservation and Recreation Lands (CARL) program designed to purchase environmentally endangered lands and recreation areas.

The Florida Game and Fresh Water Fish Commission, which manages freshwater fish and wildlife spent $16.99 million on freshwater fish programs and $13.63 million on wildlife programs in fiscal years 1976-77 to 1979-80. The number of employees in the freshwater fishery program increased from 154 to 175, and in the wildlife program it increased from 71 to 111 (Governor's Office of Planning and Budgeting 1981).

The Florida Department of Commerce promotes tourism by advertising and by surveying tourists. The Department of Commerce spent $1.68 million for tourism programs in fiscal year 1972-73 to 1973-74 with plans to spend $5.5 million in fiscal year 1980-81. The number of employees in this department that worked in various tourism related programs increased from 66 to 112 (Governor's Office of Planning and Budgeting 1981).

FEDERAL PROGRAMS

The U.S. Department of Interior (DOI) is the agency with primary responsibility for national parks and recreation related programs. Within the DOI, the National Park Service uses Land and Water Conservation Funds for purchasing parks and recreation sites. The National Park Service also evaluates and designates natural historic and cultural sites that qualify for the National Registry of Natural landmarks and National Register of Historic Places. The Service also manages an historic preservation fund that provides matching funds to the states. Since 1965, the State has acquired 73,023 acres of recreation areas from funds from the NPS, as well as the designation of six

national trails. The National Register of Historic Places in 1980 listed 347 sites. In addition, there were 19 NPS registered historic landmarks in Florida in 1980.

The National Park Service manages national parks and recreation areas, national seashores, and other natural areas. It also designates national environmental studies for these areas in cooperation with educational institutions. Ten of these areas, comprising over 1.6 million acres of land, are in Florida. The U.S. Fish and Wildlife Service manages 24 national wildlife refuges and wilderness areas in Florida that total over 451,000 acres. The Bureau of Land Management (Minerals Management Services) manages national lands including offshore bottoms beyond Florida's territorial waters. The U.S. Forest Service manages four national forests in Florida that cover about 1.3 million acres of land and contain 59 developed public recreation sites that total 1,313 acres. The U.S. Army Corps of Engineers, in conjunction with flood control and water management projects, developed 13 recreation areas of 775 acres. The U.S. Department of Defense allows public hunting within wildlife management areas on certain Air Force facilities in Florida. The U.S. Department of Agriculture and the U.S. Department of Interior jointly manage 11 designated wilderness areas consisting of 1,379,612 acres in Florida (Florida Department of Natural Resources 1981).

OUTDOOR RECREATION IN FLORIDA

Most of the data and information provided in this report were gathered from national surveys of fishing and hunting, marine recreational surveys, and surveys taken by the Florida DNR for their five-year outdoor recreation plans.

The statewide outdoor recreation demand per capita, including residents and tourists for 1970, 1975, and 1980, is given in Table 2 and participation in various outdoor forms of recreation in 1980 are given in Table 3.

Nearly 300 million man days of outdoor recreation (27% of the statewide total) were generated by Florida tourists in 1975. Bike riding and beach recreation account for about 50% of the total man days of recreation. Nearly 50% of the State's residents and 67% of the tourists participated at least once in beach recreation.

According to a study of outdoor recreation in Florida in 1981, over 400 million man days of recreation (64% of total demand) were generated by tourists. Beach and outdoor swimming pool recreation accounted for about 40% of the total demand for outdoor recreation, and nearly 75% of all residents and 80% of the tourists went to the beach at least once in 1980. The demand by tourists was greater than that of residents for saltwater beaches, swimming pools, camping, picnicking, visiting historical and archaeological sites, freshwater swimming (nonpool), saltwater fishing (nonboat), hiking, nature study, and golfing. Since 1970, bike riding and saltwater beach activities characterized the recreation of residents, whereas tourists tended to engage more in recreational vehicle camping, and freshwater pool swimming (Table 2). Residents were least active in tent camping and canoeing whereas tourists were least active in hunting.

Table 2. Per capita participation (average man days of recreation per person per year) in outdoor recreation in Florida in 1970, 1975, and 1980 (Florida Department of Natural Resources 1971, 1976, 1981).

Type of recreation	1970				1975		1980	
	Resident (Adult)	Resident (Child)	Tourist (Air)	Tourist (Auto)	Resident	Tourist	Resident	Tourist
Saltwater beach	11.8	15.0	2.9	5.0	17.4	4.5	2.4	2.1
Swimming pool	--	--	--	--	--	--	1.5	1.4
Bike riding	9.9	64.2	0.1	0.2	32.0	0.4	2.6	0.5
Recreational vehicle camping	0.3	0.2	0.1	1.9	0.5	0.7	0.2	0.9
Tent camping	0.1	0.3	0.1	0.1	0.6	0.4	0.2	0.1
Historical and archaeological sites	0.7	2.0	0.3	0.8	0.7	0.6	0.3	0.3
Freshwater swimming[a]	10.2	26.4	1.1	1.2	3.6	0.9	1.0	0.1
Saltwater fishing (nonboat)	2.1	1.30[b]	0.1[b]	0.3	6.6[c]	0.8[c]	0.6	0.2
Saltwater fishing (boat)	1.5	2.3[d]	0.3[d]	0.4	--	--	0.6	0.1
Freshwater fishing (boat)	1.6	1.9[e]	0.1[e]	0.2	5.4[f]	0.5[f]	0.7	0.1

(continued)

Table 2. (Concluded).

Type of recreation	1970				1975		1980	
	Resident (Adult)	Resident (Child)	Tourist (Air)	Tourist (Auto)	Resident	Tourist	Resident	Tourist
Freshwater fishing (nonboat)	2.8	2.5	0.1	0.2	--	--	0.6	0.1
Hiking	3.9	4.3	0.2	0.7	1.8	0.3	0.5	0.2
Nature study	4.6	5.9	0.2	0.3	3.7	0.3	0.4	0.2
Hunting	0.4[g] 0.8[i] 0.2[j]	0.2[g] 0.7[i] 0.2[j]	-- -- 0.1	-- 0.02 --	1.07[h]	0.25[h]	0.85[h]	0.85[h]
Canoeing	0.1	0.3	0.05	0.05	0.5	0.1	0.2	0.05

[a]Includes swimming pool.
[b]Surf fishing only.
[c]Includes all saltwater fishing.
[d]Fishing from boat ramp only.
[e]Fishing within lakes only.
[f]Includes all freshwater fishing.
[g]Big game.
[h]Includes all hunting.
[i]Small game.
[j]Waterfowl.

Table 3. Types of outdoor recreation and available daily supply for participating individuals in Florida in 1980 (Florida Department of Natural Resources 1981).

Type or area of recration	Available supply
Freshwater and saltwater swimming (non-pool)	2.5 linear ft of beach
Saltwater beach	100 ft^2 of beach
Boat ramp: fishing, powerboating, water skiing and sailing	160 users per single land ramp/day
Freshwater and saltwater fishing (non-boat)	6 linear ft of docking
Historical and archeological sites	384 users per site/day
Hiking	1 mi of trail per 125
Nature study	1 mi of trail per 250
Bicycling	1 mi of trail per 161
Hunting	21 acres

SPORT FISHING

The 1970 U.S. Fish and Wildlife Service's National Survey of Fishing and Hunting provides expenditure and participation data on sport fishing for the Southeastern United States. The survey showed that in 1970 about 17% of the population fished in fresh water and 11% fished in saltwater (including those that fished in both). Most fishermen were in the $10,000 to $15,000 family income bracket. The percentage of people in the Southeastern United States that fished was about 20% in 1955, 21% in 1960, 24% in 1965, and 22% in 1970.

About 2.38 million people from 1.07 million households fished for saltwater sport fish and shellfish in 1974 (U.S Department of Commerce 1977). About 2.1 million fishermen from 954,000 households sought sport fish and 989,000 sport fishermen from 419,000 households sought shellfish (includes those who fished for both). In all there were 24.68 million man days (trips) of finfishing and 8.0 million days of shellfishing. The average sport fishermen fished about 12 days for finfish and 8 days for shellfish.

The 1975 National Survey of Hunting, Fishing and Wildlife and Associated Recreation included statistics for Florida. In 1975 about 1.7 million sport fishermen fished in marine and brackish waters and 693,000 fished in rivers and freshwater lakes. In Florida in 1975, fishing expenditures were about $770.8 million. Major expenditures were as follows: $166.0 million for fishing supplies and equipment, $171.7 million for food, drink, and refreshments, $219.1 million for transportation, and $86.6 million for bait. Largemouth bass and other basses were the favored freshwater fish. The 1975 fishing cost for the 426,000 bass fishermen was about $41.8 million. An estimated 377,000 big game fishermen in boats offshore (many chartered) spent $114.42 million, whereas the 285,000 nearshore and estuarine fishermen in boats spent $46.22

million. The 1975 survey reports that the average fisherman spent $324.26 a year to fish. Individual costs were $98.15 for bass fishing, $303.51 for offshore big game fishing, and $162.17 for boat fishing.

The Fishery Conservation and Management Act of 1976 expressed Congressional concern for sport fishing. In the act, the definition of optimum sustained yield (OSY) includes sport fishing. At a minimum, the following data for any one year are needed for managing sport fisheries according to OSY guidelines: number of fishermen, average annual number of fishing days per fishermen, and the average catch per trip. Other helpful data that might be collected are: distance traveled to fish, average cost per trip, the number of trips, socioeconomic information on fishermen and their communities, and population statistics. The major problem concerning sport fishing in the Southeastern United States is the serious lack of data on catch and fishing effort.

The rise in total real expenditures and the number of days fished annually in recent decades probably is due primarily to the increased number of fishermen (Bell 1978), which may have caused a decrease in catch per unit of effort. According to Bell (1979), over $851 million in gross expenditures were spent by residents and tourists in 1975 for saltwater sport fishing in Florida (Table 4), which is about 15% of all taxable sales on recreation in the State.

The saltwater sport fishery of Florida in 1976 supported about 44 million fishing days annually (Table 4) at a cost of about $9.00 per fisherman. About one-third of the fishermen were tourists (Table 4), a statistic used for estimating that there were 14.6 million tourist days of fishing in 1975. The expenditure per man day of fishing probably is the same for tourists and residents alike. The average daily expenditure for tourists was $31.47 in 1975 (Bell 1979). Using Florida Department of Commerce information on tourist expenditures, Bell estimated that the saltwater sport fishery for tourists in 1975 created $111 million in wages and salaries in the export sector and added $464 million to the nonbase sector. Based on National Marine Fisheries Service (NMFS) estimates of retail jobs associated with sport fishing, saltwater fishing generated 34,700 jobs. Furthermore, the multiplier effect of the $464 million adds another 83,739 jobs. In all, the saltwater sport fishery supported over 118,000 jobs in Florida. The average saltwater sport fishermen spent about $19.75 a day. When multiplied by the number of tourist and resident fishing days, and applying a capitalization rate, the total value of saltwater sport fishing in Florida in 1975 was $18.7 billion.

Bell (1978) also made the same calculation for freshwater sport fishing (Table 5). He stated that:

- $526 million, in gross expenditures, is spent annually by residents and tourists on freshwater sports fishing or about 9% of all taxable sales on recreation in the state.
- Gross expenditures per day for freshwater fishing was $4.78 or 54% of daily expenditures on saltwater fishing.
- Tourist expenditures for freshwater fishing are estimated at $278 million.

Table 4. Gross expenditures and user values (both in millions of dollars) of the saltwater sport fishery in Florida in 1975 and the number of fishermen and fishing days (both in millions) according to Bell (1979).

Origin of fishermen	Gross expenditure by fishermen	User value	Number of fishing days (millions)	Number of fishermen
Resident	$392[a]	$ 872[b]	44	1.64
Tourist	$459[c]	$ 288	15	0.54
Both	$851	$1,160	59	2.18

[a] $408.39 x 0.96. (in-state participation).
[b] Angler days x individual expenditures of $19.75 per day.
[c] Number of tourists divided by resident days x $31.47 (from 1975 Florida Tourist Study)

Table 5. Freshwater sport fishing in Florida in 1975: estimated gross expenditures, user value, number of fishermen and fishing days (Bell 1979).

Type of fishermen	Gross expenditure by fishermen	User value	Number of fishing days (millions)	Number of fishermen
Resident	$247.56[a]	$397.24[b]	51.91	1.44
Tourist	$278.23[c]	$ 96.13	12.53	0.35
Both	$525.79	$493.37	148.04	1.79

[a] $272.135 million x 0.91 (in-state participation).
[b] Number of days of fishing x median user value per day (7.67).
[c] Number of tourists divided by resident days x $22.20.

- Freshwater recreational fishing by tourists creates around $70 million in wages and salaries in the export sector and an additional $293 million in the nonbase sector.

- All expenditures for freshwater recreational fishing generate about 21,775 jobs and applying the multiplier effect yields an overall total of 75,000 jobs generated by freshwater fishing.

o Capitalizing the user value of freshwater fishing yields an overall user value of $8.4 billion. (User value per day is $7.67).

HUNTING

In 1970 about 3.5% of the population in the Southeastern United States hunted big game, 7.4% hunted small game, and 1.3% hunted waterfowl. About 25% of the hunters used public lands for hunting at one time or another. The percentage of the population in the Southeastern United States that hunted was 10.1% in 1955, 11.5% in 1960, 9.2% in 1965, and 8.1% in 1970 (U.S. Department of Interior 1970).

In Florida in 1975 the 493,000 hunting licenses sold generated 10.53 million man days of hunting. Of this total, 330,000 hunted big game (3.48 million man days), 302,000 hunted for small game (4.0 million man days), 317,000 hunted for migratory birds (2.35 million man days), and 78,000 hunted for other birds and animals (652,000 man days). Of the hunters, 321,000 hunted deer (2.8 million man days) and 79,000 hunted wild turkey (454,000 man days). The hunters spent $103.1 million for big game, $54.3 million for small game, $30.4 million for waterfowl, and $1.9 million for other animals for a total of $196.6 million. In 1975, each hunter in Florida spent about $398.84 for hunting. Most of the expenses were for equipment, supplies, and transportation.

The U.S. Fish and Wildlife Service, in a press release in 1981, reported that 253,619 people in Florida spend nearly $3.7 million for hunting licenses.

SOUTHWEST FLORIDA OVERVIEW

FACTORS AFFECTING RECREATION AND TOURISM

Resource Characteristics

Socioeconomic and natural resource characteristics and factors that affect recreation and tourism in Southwest Florida are discussed in the following paragraphs.

The major socioeconomic factors for evaluating recreation and tourism are age, income levels, population size and density, and housing demand. In 1960-79, the population of Southwest Florida increased 107% (from 1.1 million in 1960 to nearly 2.3 million people in 1979). The greatest increase was in Charlotte County (413.6%) and Collier County (399.6%). Different kinds of recreation are usually preferred by different age groups. For example, young people prefer canoeing, hiking, tennis, and camping, whereas older adults prefer golf and nature study. Those people with higher incomes usually prefer beach recreation and recreational vehicle camping, but those with a lower income usually associate more with neighborhood playgrounds. Because of increased leisure time and higher standards of living in recent decades, there has been an increase in the number of seasonal (second) homes. In 1972, there were over 5,000 second homes along the Florida gulf coast.

Public recreation on beaches is somewhat limited by the shortage of public access and, in heavily populated areas, beach space (Ketchum 1972). The farther beaches are from people of low income, the less likely they are to go there for recreation. Pollution, especially oil spills, sometimes limits beach use and restricts fishing.

Major natural resources identified with recreation are aquatic life, plant communities, topography, and geological formations. Some of the interrelated socioeconomic aspects are mining, soils, climate, history, housing, industry, and institutions. Some of the most enjoyable aspects of recreation are watching ocean vessels, feeling sea breezes, watching a sunset, viewing dolphins, porpoises, or whales, or watching the waves break in the surf zone.

Climate and geographical information for Southwest Florida is provided in Table R/T 7 in the Data Appendix. The total land area of Southwest Florida is 8,574 mi^2. Hillsborough and Monroe Counties together comprise about 25% of the land area. Average annual rainfall ranges from 38 inches in Monroe County to 57 inches in Sarasota County. The average summer temperatures range from 80°F in Sarasota County to 83°F in Monroe County and the average winter temperatures range from 60°F in Pasco County to a high of 70°F in Monroe County. Figure 1 shows mean annual rainfall and temperature for the Southwest Florida region.

The marine mammal fauna of the Gulf of Mexico are discussed in a publication by the State University System of Florida (1973). The marine mammal fauna of the Gulf of Mexico consists almost entirely of whales, dolphins, porpoises, seals, sea lions, and manatees. Manatees are probably the most important species in shallow coastal waters, but they are threatened by power boats. The humpback whale and the sperm whale sometimes are seen in the gulf waters off Southwest Florida.

Some of the more important birds include horned grebe, common loon, white pelican, brown pelican, cormorant, Louisiana heron, great white heron, great blue heron, common and snowy egret, wood stork, bald eagle, osprey, seaside sparrow, roseate spoonbill, and various plovers, sandpipers, terns, and ducks.

According to a report on the Gulf of Mexico fishery, the most popular coastal fish are spotted seatrout, red drum, tarpon, Spanish mackerel, pompano, mangrove snapper, snook, and bluefish. The most common shellfish are blue crab, spiny lobster, scallops, clams, stone crab, and oysters. Offshore favorites are marlin, swordfish, sailfish, albacore, bonito, tuna, wahoo, dolphin, barracuda, cobia, and king mackerel. The sport fishery supports a sizeable bait shrimp and bait fish industry consisting largely of shrimp and small fish.

According to the Florida Audubon Society, in 1978 there were 598 rare and endangered plant and animal species in South Florida. The list of species includes 70 species of reptiles and amphibians, 16 species of fish, and 107 species of plants. Monroe County has the greatest share of rare and endangered species.

The barrier islands near Southwest Florida are most important for recreation and residential development. The percentage of land area already developed as residential areas is 85% for Clearwater Beach Island, 83% for

Sarasota, 80% for Long Key, 78% for Treasure Island, 75% for Lido Key, 74% of Anna Maria Key, 72% for Estero Island, 70% for Sand Key, 61% for Manasota Key, 48% for Gasparilla Island, 33% for Marco Island, 30% for Longboat Key, and 20% for Sanibel Island. Relatively undeveloped (less than 10% of the area) barrier islands are Caoe Romano, Rice, Keewaydin, Pine, Bay Port, Big Hickory, and the Little Gasparilla Group. Barrier islands that are protected by Federal, State, or local ownership are Ten Thousand Islands, North Captiva Island, Cayo Costa, Casey Key, Passage Key, Egmont Key, Mullet Key Group, Caladesi Island, Honeymoon Island, and Anclote Keys.

Tourism

Usually the more export dollars an area earns, the greater the economic stability. This is true in Southwest Florida because the cost of community infrastructure and social services for tourists is less than that required by residents. Travel costs, population growth, and the rate of employment are useful indices for evaluating the recreation and tourism industry. Examples are food service, employment, lodging, and transportation related jobs.

In Southwest Florida, the number of tourists increased from 2,611,716 in 1965 to 10,177,481 in 1979, an increase of 290%. Since regional statistics on tourism do not exist for tourist trade expenditures and length of stay, statewide statistics are used for calculating regional statistics based on Florida Department of Commerce tourism studies in 1961, 1965, 1970, 1976, and 1980. In 1965, the amount spent per tourist per stay was $159. By multiplying the $159 by the number of tourists visiting Southwest Florida in 1965, the estimated tourist expenditure was $415.3 million. Using similar calculations for 1980, the net economic gain since 1965 was estimated to be $2.3 billion, an increase of $1.9 billion (459%). In 1961-80, the greatest average expenditure per tourist was $346 in 1976 (for a total of $2.6 billion), but by 1980 the average expenditure per tourist declined to about $228. Nonetheless, tourist expenditures per tourist per day increased about $10 from 1976 to 1980, probably because tourists stayed for a shorter time and spent almost as much.

The abundance of tourists in an area can be judged partly by the number of restaurants and lodging places and their seating or sleeping capacities. Hotels, motels, motor courts, rooming houses, and apartments are the main lodging places. According to the annual statistical reporting units from the Florida Hotel and Restaurant Commission, the number of restaurants in Southwest Florida increased 79% (2,932 to 5,240) from 1955 to 1980 and seating capacity increased 165% (135,769 to 359,988). Although the number of lodging places decreased 8% (9,406 to 8,633), the number of units increased by 34% (135,299 to 180,677). A decrease in the number of restaurants and seating capacity in DeSoto County was in contrast to the 106% increase in the number of tourists. In the counties of Southwest Florida, the greatest percentage increases in the number of restaurants in 1955-80 was 225% for Charlotte County and 188% for Lee County. The percentage increase in seating capacity was greatest for Charlotte County (482%) and Pasco County (385%). In all, there was an increase of 2,308 lodging units (e.g., motel rooms).

Another useful indicator of tourism is the number of people employed by lodges, restuarants, and bars. As shown in Table EMP 43 in the Data Appendix, employment in Southwest Florida in lodging establishments has increased nearly 180% (6,948 to 19,410) since 1956. In 1978, there were 19 employees per

10,000 tourists which was the highest of all county ratios. Employment in eating and drinking establishments in Collier County since 1957 increased from 165 to 2,379 and similar employment in Pasco County increased from 150 to 1,934.

According to data provided by Mr. Ed Stalvey of the Florida Department of Revenue, the State of Florida collected over $455 million in sales taxes from all counties in Southwest Florida during fiscal year 1978-79. About 78% of the revenues came from Pinellas, Hillsborough, and Lee Counties. The 26-fold increase in sales tax receipts from 1955 to 1979 probably was due to the increase in the resident population and number of tourists. Sales tax per capita was $32.85 in 1960 and $20.02 in 1979.

OUTDOOR RECREATION IN SOUTHWEST FLORIDA

RESOURCES AND RESOURCE VALUES

If large Outer Continental Shelf (OCS) oil and gas discoveries were made in the Gulf of Mexico near Southwest Florida, onshore environmental impacts could have some effect on recreation that is dependent on natural resources, e.g., estuaries and beaches. The following recreation could be affected by large scale oil and gas offshore development: boating, camping, biking, fishing, hiking, hunting, horseback riding, nature study, surfing, swimming, and water skiing. Beach recreation largely is made up of swimming, sunbathing, surfing, beach combing, and shell collecting. For boating, Southwest Florida has an ample supply of docks, boat ramps, and other facilities. Fishing is good and there are many fish camps, bridges, marinas, party and charter boats, and fishing guides.

Hunting is an outdoor recreation that requires much land, sufficient quantities of game, and a high quality environment. In the forests, uplands, and wetlands in Southwest Florida, most hunting is done with a rifle, but bow and arrow hunting is becoming popular. Major game are turkey, squirrel, deer, wild boar, quail, dove, rabbits, ducks, geese, and coots.

State and local government expenditures for recreation give some indication of recreational demand and supply. County and local government expenditures for recreation were examined from County Finances and County Fee Officers Reports for 1950, 1955, 1960, and 1965 and from the local government financial reports of the State Comptroller for fiscal years 1970-71, 1975-76, and 1978-79. A 300-fold increase in local government expenditures were reported for Hillsborough and Pinellas Counties. Per capita expenditures from local governments for all of Southwest Florida in 1978-79 was $15.60. The greatest per capita expenditure for recreation was $25.40 in Hillsborough County.

The Florida Department of Natural Resources spent $283.85 million on parks and recreation programs in fiscal years 1971-72 to 1979-80. In those years the average annual increase was about $4 million and the number of park and recreation employees increased 76%.

From 1976 to 1981, the Game and Freshwater Fish Commission (GFWFC) spent nearly $17 million annually on freshwater fish programs and about $13.6 million on wildlife programs. Freshwater fish expenditures increased $114,000 annually and wildlife expenditures increased $312,000. The number of employees in freshwater fishery programs increased from 154 to 175.

Florida is one of the most highly developed recreational areas in the United States. The major recreation areas are local, State, and national parks, forests, wildlife refuges, historical/archaeological sites, game preserves, and public and private beaches. The State recreation areas in Southwest Florida are listed in Table 6. Other recreational areas are scenic and wild rivers, canoe trails, and fish management areas. In Southwest Florida, the Hillsborough River in Hillsborough and Pasco Counties is under study by the State for designation as a scenic and wild river. The Federal Government also is studying the possibility of designating the Myakka River in Manatee, Sarasota, and Charlotte Counties as a scenic and wild river.

Table 6. Recreation areas in the counties of Southwest Florida (Florida Department of Natural Resources, Divison of Recreation and Parks 1981).

County	Recreation area
Collier	Wiggins Pass, Collier-Seminole
Hillsborough	Hillsborough River, Ybor City
Lee	Koreshan
Manatee	Myakka River, Lake Manatee, Judah P. Benjamin, Madira Bidle Mound
Monroe	Bahia Honda, Indian Key, Pennekamp, Lignamvitae Key, Long Key, Fort Taylor
Pinellas	Caladesi Island
Sarasota	Oscar Scherer

State designated canoe trails or streams in Southwest Florida are the Pithlachascotee River (Pasco), Alafia and Little Manatee River (Hillsborough), Upper Manatee River (Manatee), Peace River (DeSoto), Hickey's Creek (Lee), Estero River (Collier) and Blackwater River/Royal Palm Creek (Collier).

The National Park Service has a designated canoe trail in Monroe County located at Bear Lake and the Wilderness Waterway. The Florida Game and Freshwater Fish Commission manages the following waters: Lake Moon (Pasco County), Lake Tayson and Lake Seminole (Pinellas), Lake Thonotosassa (Hillsborough),

Manatee Lake (Manatee) DeSoto Pond (DeSoto), Marl Pits 1, 2 and 3, and Webb Area Reservoir (Charlotte). The National Register properties located in Southwest Florida are the Seaboard Coastline Railroad in Naples Park, the Koreshan Unity Settlement Historic District, Mound Key on Estero Island, and the Sanibel Lighthouse and Keeper's Quarters on Sanibel Island. The counties primarily supply a combination of resource-based and user-oriented recreation areas. Typical city-owned recreational areas are playgrounds, swimming pools, ballfields, golf courses, and tennis courts.

In 1980 there were about 58,567 acres of private recreational lands (Table R/T 21 in the Data Appendix). This includes 50,191 acres of hunting area, 594 boat ramps, piers, and marinas, and 5,752 linear ft of saltwater beach frontage. Of the counties, Lee County (35.9%), Collier (31.9%), and Charlotte County (30%) had the greatest percentage of private hunting areas, but Monroe County had the greatest number (194) of private boat ramps, piers, and marinas.

Based on Tables R/T 17-20 in the Data Appendix, there were 2,282,515 acres of Federal, State, and local public recreation areas in Southwest Florida. The saltwater beach frontage was nearly 80 miles long. Among the counties, Monroe County had the greatest percentage of recreation area (47.5%) and beach frontage (71.2%). Collier County had 39.8% of all public recreation area in Southwest Florida in 1980 and Charlotte County had 29.2%. Public recreation contributed nearly 40 times more recreation area (2.3 million acres) than the private sector (58,567 acres) and over 71 times more saltwater beach frontage (about 78 miles compared to 1 mile).

Most public recreational lands are owned by Federal, State, county, and municipal governments. In Southwest Florida in 1980, the Federal Government owned 1,620,578 acres including 57,000 acres of hunting area and 18.2 miles of saltwater beach frontage. Monroe County (62.2%) and Collier County (37.5%) had the greatest percentage of all Federal recreation areas in the region. All hunting areas were located in Collier County. Nearly all (95,000 linear ft; 98.6%) of the federally owned saltwater beaches are in Monroe County. The J.N. Ding Darling, Key Deer, Great White Heron, Pine Island, Passage Key and Egmont Key Wildlife Refuges are located in Monroe County.

In Southwest Florida the State owns about 637,370 acres or 28% of all public recreation areas. Collier County has 300,000 acres (47%) of all State owned recreation lands, and about 284,934 acres (69%) of all public hunting lands. Collier County provided 70.2% of all State hunting areas and Monroe County contributed 83.2% of the 237,896 linear ft (45.1 mi) of the State saltwater beach frontage.

For recreation, county and municipal (local) governments own or maintain beaches, boat ramps, piers, and marinas. Of the 24,567 acres of local recreation areas, Pinellas and Hillsborough Counties contribute 31.2% (7,657 acres) and 29% (912 acres), respectively. Local governments also own and maintain 111 boat ramps, piers, and marinas for boaters and sports fishermen. Local governments own 14.7 linear miles of saltwater beach frontage.

In 1980, Southwest Florida had 4,032 historical and archaeological sites. Most (1,203) were in Monroe County and in Hillsborough County (999). Florida's coastal zone management program in 1975 reported that there were 324

historical and archaeological sites, 169,199 acres of wildlife refuges, and 6,693 acres of forestry and game management areas in Southwest Florida.

CURRENT RESOURCE USE AND PROJECTED RECREATIONAL DEMANDS

Most of the observations in this section were taken from tables and figures in the Data Appendix (i.e., Table R/T for Recreation and Tourism). More detailed information, especially for individual counties, can be had by further examining the appropriate tables and figures in the Appendix.

The future demands for recreation and tourism in Southwest Florida and its counties were calculated by determining the ratio of man days of participation (or trips) in Florida per 100 residents (e.g., 84 fishing days per 100 people in the population of Collier County). The ratio is multiplied by the number of residents in a particular year and county to get the projected demand.

For continuity in this report, fishing intensity or any form of recreation usually is expressed in man days or visits (e.g., the average annual number of days of fishing per individual times and number of fishermen).

PARKS AND RECREATION AREAS

The number of visitors at State parks and recreation areas in Southwest Florida increased about seven-fold from fiscal years 1955-56 to 1979-80. The change probably was caused by the addition of new parks and recreation areas. From fiscal years 1972-73 to 1975-76, the number of visitors to State parks decreased 60% probably because of increased transportation costs. Of the 2,067,262 visitors to State parks and recreation areas in 1980, about 511,000 attended Wiggins Pass or Collier-Seminole State Parks in Collier County. Nearly 800,000 attended the six State parks and recreation areas in Monroe County, of which 50% visited John Pennekamp State Park, the Nation's only underwater park.

The U.S. Department of Interior (1979) reported about one million visitors each year in the Everglades National Park and National Seashore.

SPORT FISHING

This description of the fishing industry includes information on freshwater and saltwater sport fishing, and on the economic impact of sport fishing based on computations by Bell (1978).

The number of freshwater fishing licenses issued to out-of-state (tourist) fishermen and other related data are given in Tables R/T 35-40 in the Data Appendix. Licenses are issued for 5-day, 14-day and 12-month periods. In fiscal year 1954-55, the Florida Game and Fresh Water Fish Commission (GFWFC) issued 4,930 out-of-state freshwater fishing licenses in Southwest Florida. In fiscal year 1979-80, this figure increased to 16,501 (235%). The sale of resident fishing licenses increased only 6.8% (46,147 to 49,267) from

1954 to 1980. In 1960, the ratio of resident freshwater fishing licenses issued to the population in Southwest Florida was six licenses per 100 residents. By 1980, the ratio had decreased to two per 100 residents. The demand for freshwater fishing in Southwest Florida is expected to increase about 29.5% (from 1.8 million to 2.3 million fishing trips per year) from 1980 to 1990. Hillsborough, Pasco, and Pinellas Counties will contribute about 75% of the demand in the near future.

The National Marine Fisheries Service (U.S. Department of Commerce 1980) provided most of the following saltwater sport fishing statistics for the gulf coast including Florida. Major saltwater sport species by catch are spotted seatrout (Cynoscion nebulosis), Atlantic croaker (Micropogonias undulatus), pinfish (Lagodon rhomboides), striped mullet (Mugil cephalus), and sand seatrout (Cynoscion arenarius). Seabass also is a popular species. In the Florida gulf area, there were 9,530,000 fishing trips, of which 7,280,000 were by coastal residents, 27,000 by noncoastal residents, and 2,233,000 by out-of-state tourists. The estimated number of saltwater fishing trips in the Florida gulf area was 2,146,000, of which 1,243,000 were coastal residents, 5,000 noncoastal residents, and 898,000 tourists. The average annual number of trips per year per licensed fishermen was 5.9 for coastal residents, 5.4 for noncoastal residents, 2.4 for tourists; 4.4 for all. The average fishing trip lasted 3.8 hours and cost $10.20. In 1980, the average saltwater fisherman fished 16.9 hours, spent $45.29, and traveled 248 miles.

Annual capital expenditures for manufacturing, wholesale, and retail trades for tackle, boats, motors, and trailers was $1.225 million (U.S. Department of Commerce 1980). A recent decline in the total catch and catch per unit of effort by sport fishermen suggests possible overfishing in some areas. Most sport fishermen are restricted to inshore waters because their boats are too small for the sea. Southwest Florida is characterized by boats that cater to tourists.

Spiny lobsters, the major commercial species, are taken during the regular commercial spiny lobster season, and by sport fishermen during the special two-day sport season on 20-21 July (according to the Fishery Management Plan of April 1981). An estimated 2,478 boats with 7,607 divers caught 15,190 lobsters in Monroe County. The estimated sport catch from boats was about 448,000 pounds per year. Based on recent tagging studies, the sport catch of spiny lobster made up 9% of the total catch. Daily expenditures for spiny lobster fishing were $45 to $60 for interior county fishermen and $18 to $27 for coastal county fishermen. In 1975, divers for spiny lobsters spent $3.1 directly and $4.2 million indirectly for supplies, equipment, food, and travel. The income from those lobsters sold by divers was between $500,000 and $600,000. A conservative estimate of the number of employees associated with the spiny lobster fishery was about 1,700.

About 10.5 million saltwater fishing trips were made in Southwest Florida in 1980 and about 12 million are expected in 1985 and 13.222 million in 1990 (Tables R/T 8-16 in the Data Appendix) for an increase of 26.4%. In 1980, the ratio of the demand for saltwater fishing to the total population (demand factor) was 84 trips per 100 people.

A study of the structure and economics of the pay-boat fisheries of the Florida gulf coast and the Keys from Pensacola to Key West was made by Browder

et al. (1978). A study identified offshore charter boats, inshore/offshore charter boats for bays, offshore guide boats for back country fishing, and head boats. Head boats carry large numbers of passengers and operate on a per customer basis rather than by charter (Table 7).

In Southwest Florida in 1980, there were 253 offshore charter boats, 17 inshore/offshore charter boats, 129 guide boats, and 44 head (party) boats. Offshore charter boats fish largely near reefs for snapper and groupers in the spring and fall. Reef fishes and tarpon (Megalops atlantica) are the most important species caught by inshore/offshore boats. Tarpon are fished primarily out of Boco Grande and Tampa. Snook (Centropomus undecimalis), red drum (Sciaenops occelatus), tarpon, and seatrout also are taken in abundance, especially from guide boats. Snapper and groupers contribute about 65% to 75% of the catch by head boats, followed by grunts and seabass. The Key area has the greatest variety of fishing, about one-half of which is in the blue waters. Dolphin (Coryphaena spp.) and billfish, usually classified as big game fish, are abundant. Bonefish (Albula vulpes) and tarpon are the most highly valued guide boat species.

The average number of fishermen per boat trip and the percentage of fishermen from out-of-state (in parenthesis) were 6.3 (63%) for all boats, 6.0 (78%) for inshore/offshore boats, 4.0 (49%) for guide boats, and 6.4 (60%) for head boats.

The net revenue for offshore charter boats in 1960 was $5,106 per vessel in the Gulf of Mexico and $11,428 per vessel in the Keys. Inshore/offshore boat revenue was $4,371 per boat and guide boat revenue was $8,130 per boat. In 1960 there were 254 charter boats and 37 head boats; in 1977 there were 259 and 45, respectively.

As indicated before, the total value of saltwater sport fishing in Florida is $18.7 billion based on 58.74 million fishing days. On that basis, it

Table 7. Location of charter fishing boat marinas (adapted from Browder et al. 1978).

Type of boat	Activity center
Offshore charter	Islamorada, Marathon, Key West, Clearwater, Fort Meyers Beach, Naples, Marco Island
Inshore-offshore	Boca Grande, Naples, Marco Island, Key West
Guide-boat centers	Sanibel-Captiva, Marco Island, Everglades City, Key Largo, Islamorada, Marathon, Big Pine Key
Head boats	Key Largo, Islamorada, Marathon, Key West

is estimated that the total expenditure per fishing day was $318.35. Since there were 10.459 million man days of saltwater sport fishing in Southwest Florida, the total value of saltwater sport fishing was $3.333 billion. Based on a figure of 118,000 jobs related to saltwater sport fishing in Florida, every 1,000 man days of fishing supports two employees. Based on 10.459 million man days of saltwater sport fishing in Southwest Florida in 1980, the fishery supports 20,918 jobs. The value of the fishery is projected to be about $3.821 billion in 1985 and $4.210 billion in 1990. The number of jobs should increase from 24,000 to 26,400.

Similar calculations apply to the freshwater sport fishing. Each man day of fishing adds $130.59 to the economy and each 10,000 man days supports 12 jobs (Bell 1978). As shown in Tables R/T 8-16 in the Data Appendix, the expected demand for freshwater fishing is 1.774 million fishing days in 1980, 2.083 million in 1985, and 2.297 million in 1990. The freshwater sport fishing industry in 1980 was valued at $23.670 million and supported 2,219 jobs. In 1985-90, the value of the fishery is expected to increase from $272.020 million to $299.970 million and the number of jobs should increase from 2,500 to 2,756.

HUNTING

A comprehensive analysis of the recreational value of the hunting industry and its effect on the socioeconomic structure was prepared by Gibbs (1975) from which some of the following observations were taken, and from Tables R/T 8-16 in the Data Appendix.

The total value of all hunting in Florida was $294 million based on 6 million man days of hunting. Annual hunting expenditures in Florida are estimated at $116 million.

The number of out-of-state hunting licenses issued gives some measure of hunting demand. The 10-day or 12-month licenses may be issued in a particular county, but the licensees may hunt in several counties. In 1954-55, only 195 out-of-state licenses were issued in Southwest Florida, but by 1979-80, 2,086 were issued.

In 1965-66, one out-of-state hunting license was issued per 100,000 tourists, but in 1979-80 the ratio was one in 200,000. Based on the number of hunters and the area of available hunting grounds, 188 acres were available for each out-of-state hunter.

The number of resident hunting licenses issued in Southwest Florida increased from 9,545 in fiscal year 1954-55 to 22,558 in fiscal year 1979-80, an increase of 136%. In 1960, 14 resident licenses were issued per 1,000 residents, but by 1980 the ratio dropped to 10 per 1,000. The largest number of resident licenses were sold in Hillsborough and Pinellas Counties. Based on the area available for hunting in Southwest Florida in 1980, there were about 17 acres per licensed resident hunter. The hunting area for both resident and out-of-state licenses was about 16 acres per hunter.

The intensity of hunting in Southwest Florida was 508,500 man days of hunting in 1980, projected to 726,100 in 1990, a 42.8% increase. Nearly 60%

of the expected demand for hunting will be in Hillsborough and Collier Counties. The demand factor for hunting in 1980 was four trips per 100 residents and tourists.

Based on the expenditure of $47.43 per hunting day (Gibbs 1975) the 1980 value of all hunting to the economy of Florida was $24 million. Projected values are $31 million in 1985 and $34 million in 1990.

OTHER SPORT AND RECREATIONAL ACTIVITIES

The expected demands for various resource-based outdoor recreation in Southwest Florida in 1980, 1985, and 1990 are given in Tables R/T 8-16 in the Data Appendix. Activities include saltwater beach recreation, freshwater swimming (non pool), camping, nature study, canoeing, boating, hiking and bike riding. The projections given in these sections for Florida are based on the 1980 population of 12.4 million tourists and residents. Projected populations for the counties are pro-rated from the 1980 estimates. The demand factors are the number of man days of participation or visits per 100 people.

Saltwater Beaches

The projected number of man days of visits to beaches in Southwest Florida is expected to be 48.1 million in 1985 and 49.2 million in 1990. The small (3.2%) increase is expected because of overcrowded beaches. The greatest demand for beach use will be in Pinellas County. The demand is 143 visits per 100 people (e.g., a county with one million people would expect 1.43 million man days of beach recreation).

Freshwater Swimming

In Southwest Florida the demand for freshwater swimming (ponds, lakes, and rivers) is estimated to be 1.9 million man days of swimming in 1985 and 2.0 million in 1990, an increase of 28.4%. The demand is 13 man days of swimming per 100 people.

Recreational Vehicle Camping

The demand for recreational vehicle camping in Southwest Florida in 1980 was 15.4 million man days of camping, 124 man days per 100 people. The projected demand is 17 million in 1985, and 18.8 in 1990, an increase of 21.5%.

Tent Camping

In 1980-90, the man days of tent camping is expected to increase from 632,100 to 782,600, an increase of 23.8%. Nearly 90% of the demand will be in Monroe, Pinellas, and Hillsborough Counties. Greatest percentage increases will be in Charlotte, Collier, and Lee Counties. The demand is 5 man days of camping per 100 people.

Nature Study and Historical and Archaeological Recreation

In 1980-90 man day visits are expected to increase from 8.1 million to 11.2 million, an increase of 37.6%. The increase will be greatest in Lee

County (150%). About 70% of the future demand (site visits) will be in Pinellas, Hillsborough, and Monroe Counties. The demand is 6.5-man day visits per 100 people.

Pleasure Boats

Most of the data in this subsection is from Table R/T 28 in the Data Appendix. Pleasure boat registrations are the best indications of their value for recreation. In Southwest Florida, boat registrations increased from 37,608 in fiscal year 1965-66 to 127,550 in fiscal year 1978-79, an increase of 239%. The increase in the number and percentage of boats was 1,215 to 7,710 (534%) in Pasco County, 1,248 to 6,276 (403%) in Charlotte County, and 1,670 to 8,308 (397%) in Collier County.

The resident and tourist demand in 1980-90 for canoeing in Southwest Florida will increase from about 250,300 to 326,700 (30.5%). The demand is 2 man days of canoeing per 100 people.

Hiking

In 1980, there were 5,206,000 man days of hiking in Southwest Florida. By 1990, this demand is expected to increase to 6,945,700 (33.4%). Those counties showing the greatest increase will be Pasco, Charlotte, and Lee Counties. Over 55% of the demand for hiking is in Pinellas and Sarasota Counties. The demand is 4.2 trips per 100 people.

Bike Riding

From 1980 to 1990, the demand for bike riding in Southwest Florida is expected to increase from 13,608,300 trips to 17,295,800 trips. The demand is 110 bike trips per 100 people.

User-Oriented Recreation Demand

Golf, tennis, and pool swimming are the three most important user-oriented types of recreation in Southwest Florida. Demands for 1980, 1985, and 1990 are in Tables R/T 8-16 in the Data Appendix.

The demand for golfing is expected to increase from 6,157,400 man days of golf in 1980 to 7,819,900 in 1990, an increase of 27%. Over 55% of the 1980 to 1990 demand will be in Pinellas and Sarasota Counties. Among the counties, the greatest predicted increase will be 409,400 to 557,900 (36.3%) in Lee County 206,300 to 298,000 (34.8%) in Pasco County, and 137,600 to 182,200 (32.4%) in Charlotte County. The demand is 50 man days of golf per 100 people.

Tennis

In 1980, the demand for tennis in Southwest Florida was 3,459,100 man days. This demand is expected to increase by 28% in 1990. Those counties showing the greatest percentage increase in demand from 1980 to 1990 are Pasco County (50.9%), Charlotte County (41.7%), Collier County (32%), and Lee County (30.7%). Over 50% (2.35 million games) of the demand for tennis will be in Pinellas and Hillsborough Counties. The demand is 30 man days of tennis per 100 people.

Pool Swimming

The demand for days of swimming in pools was 20.5 million in 1980, and projections are for 23.0 million in 1985 and 25.4 million in 1990. The increase in demand from 1980 to 1990 will be 23.9%. About 75% of the demand for swimming in pools will be in Pinellas, Hillsborough, Lee, and Sarasota Counties. The demand is 165 man days of swimming in pools per 100 people.

POTENTIAL IMPACTS OF OCS OIL AND GAS EXPLORATION AND DEVELOPMENT

In 1974, about 60% of the public that was polled favored offshore drilling for oil in Florida in response to the energy crisis. In 1979 it was 69%. Most (60%) Floridians want to promote tourism even if the tourists reduce available supplies of gasoline. Only 25% of those polled oppose increased tourism because of a drain on the State's energy supplies (Bell et al. 1980).

A report by Havran and Collins (1980) on OCS oil and gas activities in the Gulf of Mexico and their onshore impacts is valuable for assessing potential environmental impacts on coastal Florida. Gulf of Mexico OCS production platforms in Texas and Louisiana are linked to shore by an extensive network of pipelines that transport oil and gas to nearby terminals. The production of oil and gas sometimes led to the growth of massive onshore industrial complexes that cause many environmental problems. The most severe onshore environmental impacts are apparent in frontier areas where few of the needs for onshore operations and facilities are available. Since port facilities along the Florida coastline are not geared for OCS oil and gas development, any high or moderate level oil and gas find along the Florida gulf coast could cause local economic and community upheavel.

The potential for oil pollution is a major issue raised by offshore oil drilling. Leaks from pipelines and platforms potentially could have some damaging effects on sport and commercial fishing, saltwater beach recreation, and boating. Pipeline construction may disrupt the bottom habitat and destroy benthic organisms. Even buried pipelines may threaten beaches or residential sites. In addition to terminal sites and channels, turning basins may need to be dredged or maintained for deep draft tankers. Loss or alteration of coastal lands and water would reduce recreational potentials.

A substantial work force may be required for the construction and operation of the necessary onshore facilities for OCS oil and gas development. Tourists are not usually attracted to areas where onshore activities are heaviest. Rapid industrial growth in some coastal areas could cause a decline in tourism. Because the recreation required in a community is a function of the size of the population and its demographic characteristics, population change due to OCS oil and gas activities would alter recreational demand and supply in the community.

Funds for recreation may be sharply increased by revenue collected from offshore oil and gas extraction. The Land and Water Conservation Fund is the major Federal grant program to the states for purchasing and developing outdoor recreation areas. This fund also has been used to purchase recreation areas and endangered species lands in national forests, parks, wilderness

areas, wildlife refuges, and wild and scenic rivers. The U.S. Department of Interior, Bureau of Land Management (1981) reports that 65% of the revenue for the fund are derived from bonuses, leases, and royalties stemming from exploration and production of oil and natural gas from Federal OCS areas.

Oil spills from pipelines sometimes are caused by damage from dragging platform anchors and bottom trawls. Blowout spillage is caused by producing wells. A serious blowout in 1980 in the southern gulf area off the coast of Mexico threatened one of the world's richest shrimping and fishing grounds. Severe storms sometimes cause oil spills. In 1964, about 12,000 barrels of oil were spilled from storage tanks in Louisiana during Hurricane Hilda. Accidental oil spills from tankers and barges and oil discharged under normal operating conditions are the major oil spill sources. A large oil spill can kill birds and marine organisms, weaken key links in the food chain necessary to support sport fisheries, and modify coastline habitats. In addition to these biological impacts, oil spills can create aesthetic and socioeconomic problems including the cost of beach cleanup, loss of recreationally related businesses, and the fouling of fishing boats and gear.

Potentially, any one of four levels of OCS oil and gas activity could threaten Southwest Florida (Hodecker 1981). Exploratory drilling likely would not cause measurable onshore impacts. A low-find scenario near the gulf coast of western Florida could require a small permanent supply base and repair and maintenance yards, and other ancillary services. Pipelines would be needed to carry the crude oil to marine terminals where the crude would be stored. Gas processing and treatment plants would be located at each landfall site. A medium-find scenario would require two permanent bases in Southwest Florida, two pipelines, two marine terminal facilities, and two gas processing plants if oil fields are located offshore from Sarasota and Collier Counties.

For high-find oil and gas operations, at least two and possibly three bases would locate in Southwest Florida. Ancillary facilities, two pipelines, marine terminals, and gas processing plants would locate at each landfall site. A refinery may be needed in Southwest Florida if discoveries of oil and gas are high (Hodecker 1981).

Based on data provided by the New England River Basins Commission (1976), Dzurik in his synthesis paper on "Minerals" provided tables of the general impacts from siting various OCS onshore facilities. These impacts, in terms of employment and land area needed for a high-find scenario, are given in Table 8. Over 3,000 acres of coastal land and 3,000 linear ft of waterfront would be needed for OCS onshore facilities. Some of this loss would be recreational land. Using the demand factors for various types of recreation, estimates of the number of recreation days required by the additional employment related to OCS activities can be made (Table 9). Over 11,000 days of various recreation activities would be demanded by those employed by OCS related industry.

Table 8. Onshore facilities and number of jobs required to support a high-find of oil and gas in the Outer Continental Shelf near Southwest Florida (adapted from the New England River Basins Commision 1976).

Facility	Land measure	Number of jobs required
Service bases	100 acres/base, 600 ft water frontage per base	80 jobs per platform during drilling and production
Pipelines	100 ft easement/pipeline 190 acres per pipecoating yd and pumping station 850 lineal ft of water frontage	500
Berthing facilities (terminal and tank form)	150 acres 1,000 lineal ft of water frontage	75
Platform fabrica tion yards	800 acres 450 lineal ft water frontage	
Onshore process ing and treat-ment facilities	75 acres	60
Refinery	2,000 acres	600
Total	3,315 acres	1,315

Table 9. Estimated outdoor recreation needs by 2,110 employees in Southwest Florida hired in relation to OCS oil and gas development based on conditions in 1980.

Type of outdoor recreation	Average man-days of participation per person (X100)	Estimated man days[a] of recreation
Freshwater sport fishery	14	299
Saltwater sport fishing	84	1,722
Hunting	4	84
Saltwater beach recreation	321	6,773
Freshwater swimming	13	274
Recreation vehicle camping	124	2,616
Tent camping	5	106
Historical and archaeological	65	1,372
Canoeing	2	42
Hiking	42	886
Bike riding	109	2,300
Golf	49	1,034
Tennis	28	591
Swimming pool use	165	3,482
Total		21,634

[a]Average per person times 2,110.

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COMMERCIAL AND SPORT FISHERIES

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INTRODUCTION

OVERVIEW

The State of Florida is known for its valuable coastal resources and their potential. The State has 11,000 mi of tidal shoreline (second longest in the United States) and over 15 major estuarine systems. Climatic conditions range from subtemperate to tropical. The vegetation ranges from tropical hammocks of the Keys to the massive mangrove stands of southwest Florida, and to the juncus and spartina marshes of northwest Florida and the panhandle. These habitat types are undergoing more and more stress. About 75% of Florida's more than nine million residents (1980 Census) live within a few miles of the coastline and over 60% of the 36 million tourists who come to Florida annually engage in fishing, swimming, sun bathing, boating, beach combing, and other water-related forms of recreation. In combination, these activities are depleting or threatening Florida's natural coastal resources.

This paper concerns the sport and commercial fishing industries, the fishes and their biology, and fish production, value, and management. Much of the catch data are from the National Marine Fisheries Service annual catch reports. Much of the economic analysis is provided in publications by Cato (1973), Prochaska (1976), Prochaska and Cato (1977), Prochaska and Morris (1978), and Prochaska et al. (1981) at the University of Florida in Gainesville. Much of the biological data are from Steidinger (1980).

Southwest Florida (Pasco, Charlotte, Collier, DeSoto, Hillsborough, Lee, Manatee, Monroe, Pinellas, and Sarasota Counties) has some of the most beautiful beaches in the State and valuable sport and commercial fisheries. Rapid population growth in Southwest Florida and intensified residential and industrial development are destroying or altering natural coastal environments. The massive dredge and fill operations that created waterfront-canal home sites in Boca Ciega Bay, Pinellas County, is an example of extreme habitat alteration with thousands of acres of productive estuarine habitat being dredged and filled. Another example of a major change was the modification of freshwater flow through the Everglades for flood control and land reclamation. The reduced and otherwise modified seasonal freshwater flow has contributed to excessive change in the salinity of estuaries. Long-term salinity changes may have far reaching effects on the distribution and abundance of fish and shellfish.

Despite these and the many other changes wrought by man, Southwest Florida still has an abundance of valuable estuarine and marine resources. Because of its productivity, estuaries have natural ecological characteristics and resources that should respond well to habitat restoration measures currently being developed in Florida. Some areas cannot be restored, such as some of the large coastal suburban developments, but vigorous environmental planning for new developments will provide new opportunity for habitat protection, mitigation, or restoration.

COASTAL RESOURCES

Southwest Florida has some of the richest and most productive estuarine and nearshore marine areas in the world. There are nine major estuaries (Tampa Bay, Boca Ciega Bay, Sarasota Bay, Charlotte Harbor, Pine Island Sound, Estero Bay, Ten Thousand Islands, Whitewater Bay, and Florida Bay) and many small tidal creeks, rivers, and lagoons, most of which are connected by the Intracoastal Waterway. The coastal waters extend over a very broad continental shelf which increases as little as one foot in depth per mile seaward in the more northern counties. Because of the shallow water and lower salinities, the nearshore waters of the coast function almost like an estuary, which add greatly to the productivity of the coastal waters, and help compensate for some of the damage done to coastal wetlands and estuaries.

The nearshore waters of Southwest Florida support extensive sport and commercial fisheries according to Moe (1963). He divided the coastal area into the upper west coast (characterized by a gentle gradient to the 50-fathom contour almost 100 mi from the shore), the lower west coast (characterized by a broad coastal shelf as deep as 100 fathoms from 117 to 150 mi offshore), and the Florida Keys (characterized by a chain of islands composed of coral rock). The coastal waters, characterized by rock outcroppings, ledges, cliffs, gullies, and other perturbations on the bottom provide an abundance of good sport and commercial fishing spots.

COASTAL CURRENTS

The prevailing oceanic currents of the Gulf of Mexico are complex and help characterize the biology of Southwest Florida. Drift bottle data and monitoring via satellite imagery are contributing to a better understanding of the diverse factors influencing mass water transport in the region. These methods for tracking currents show that coastal currents of Southwest Florida are highly variable and depend on the pattern of Loop Current development (intrusion, spreading, eddy formation, and drift), which is unpredictable and affected by short-term weather variations and prevailing local winds (Williams et al. 1977). Although unpredictable, the Loop Current, its eddies, wind effects, and other variables closely link Florida's western shelf with other coastal waters of the State. These currents have already been documented in studies of the red tide (Steidinger 1981).

With drift bottle and bloom transport verified, the possibility of even more dangerous substances, both natural and manmade, being readily transported from the lower west Florida coast to the Northwest coast or the east coast is very strong depending on the condition of the surface current pattern and structure at the time.

COMMERCIAL FISHERIES

Commercial and subsistence fishing has been a practice of long standing in Southwest Florida. Extensive Indian shell middens attest to the importance of this food source in past centuries. Even in its simplest form in the early 1900's, commercial fishing required substantial investment in gear or equipment, such as boats, beach seines, and gill nets. Marketing was severely limited by the lack of proper storage, preservation, and transportation. Unless a day's catch was dried or salted, most had to be sold on the same day they were caught. In contrast, much of today's modern fishing industry is a complex of vessels, sophisticated electronic equipment, freezing and storage facilities, transportation, and marketing systems.

Fishery resources may provide a reliable supply of low-priced protein. This is particularly true for schooling nearshore estuarine species such as mullet, croaker, trout, and redfish. A recent survey conducted by the Bureau of Marketing and Extension Services of the Florida Department of Natural Resources revealed the importance of low-priced commercial fish in ethnic diets. This survey is important because commercial fishing with nets is becoming increasingly unpopular with the general public and further restrictions on that kind of fishing will reduce the catch of less expensive fishes.

Excellent and detailed economic analyses of a variety of fisheries in specific areas have been reported by Cato and Prochaska (1975, 1976, 1977). Statistical data on the composition of the commercial fish and shellfish landings for Florida and Southwest Florida and its counties are given in tables FSH 1-42, pages 182-236, Volume II, Data Appendix, this report.

FISHERY RESOURCES OF SOUTHWEST FLORIDA

Over one hundred species of finfish and shellfish are caught by commercial and sport fishermen in Southwest Florida. Unfortunately, very little information is available for sport catches and none on a regular or annual basis. The National Marine Fisheries Service has attempted nationally through direct interviews and telephone surveys to get some feeling as to the magnitude of this catch (Deuel and Clark 1965, Deuel 1970, 1975, 1979, U.S. Department of Commerce 1975, 1979). A creel census-interview study by Florida DNR (Irby 1974) looked intensively at a small relatively pristine area (Choctawhatchee Bay). Efforts are now underway to establish continuing commercial and sport catch statistics, through State/Federal cooperative agreements.

Most of the following discussion is based on commercial statistics, but existing evidence indicates that for those species actively sought by both sport and commercial fishermen, sport catches often equal or exceed commercial landings. Reports on commercial landings, value, and prices of the coastal fishes of Florida were published by Cato and Prochaska (1975, 1977); some of the data are used in the following sections. In any review of commercial landings, care must be exercised to avoid oversimplification in analyzing the data. For example, several years of steadily declining catches do not necessarily indicate that the species is overfished. For example, the decline in catch may be caused by normal annual fluctuations or a decline in commercial

fishing intensity. Descriptions of some of the major fish and shellfish are given in the following sections.

FINFISH

Ordinarily, seafood is divided into finfish (referred to as fish hereafter in this report) and shellfish (e.g., oysters, shrimps, crabs). In addition to their commercial value, finfish support a highly valued sport fishery.

Snappers and Groupers

Seven species of snappers are taken in the Florida fishery. Red snapper is the most valuable and makes up most of the catch. Red snapper landings in Southwest Florida averaged about 995,000 lb annually in 1970-80 (about 25% of the statewide red snapper landings).

Commercial landings of groupers in Southwest Florida have been relatively stable, averaging a little over 5 million pounds annually since 1965. Monthly catches also are relatively stable except for slight declines in January and February. The landed value in 1980 was just under $1.00 a pound.

Relatively little is known about the early life history of snappers and groupers. Only a few of the larvae among the snapper species have been described and specific areas of spawning are unknown. Most fish probably spawn in deeper coastal waters in spring, summer, and fall and the pelagic larvae are transported by prevailing currents to shallow coastal waters and estuaries which are used as nursery grounds (Beaumariage and Bullock 1977). As juveniles they move from shallow reefs or grassy areas to deeper holes or hard bottom outcroppings. Adults seldom stray far from hard rock outcroppings, reefs, or corals because of their need for cover in protective holes and crevices. The size and growth rates of each species of grouper varies.

Although the biological characteristics of each species of grouper may vary, the gag (*Mycteroperca microlepis*) has been studied the most. This species in its second year of life is about 14 inches long and weighs between 2 and 3 lb. Most of the largest groupers landed commercially are 5 or 6 years old and average 20 to 25 lb. Maximum age is about 30 years. Sexual maturity is reached in 2 to 4 years, and most groupers are protogynous hermaphrodites which begin life as females. Transformation to males begins at about age six, but not all become males. Factors causing sexual change are not understood, but the purpose probably is to prevent the loss of males from the highly territorial populations found in the relatively isolated reef areas.

Red snappers are long lived (up to 20 years), slow growing, deep reef dwellers (Futch and Bruger 1977). They are essentially non-migratory except for seasonal inshore-offshore movement. They eat shrimp, crabs, other crustaceans, and fish.

The increasing competition for snappers and groupers by commercial and sport fishermen in Florida may be reducing the abundance of these species to relatively low levels. The closing of Mexican fishing grounds to Southwest Florida fishing fleets has diverted even more fishing pressure toward the

snapper and grouper populations near Florida. The increasing use of fish traps to catch snappers and groupers in Southwest Florida waters has been strongly opposed by sport fishermen and has led to various legislative actions to restrict or prohibit the use of fish traps.

King Mackerel

King mackerel (Scombermorous cavalla) is a valuable sport and commercial fish in the coastal waters of Southwest Florida. Annual commercial landings in Florida averaged 2.7 million lb in 1970-80, but the sport catch was roughly estimated at about three times that much. The fishery management plan currently under preparation by the Gulf of Mexico and South Atlantic Regional Fishery Management Councils (Public Law 94-265) seeks to allocate 9 million lb annually to the commercial fisherman (approximately 5 million lb to nets and 4 million lb to hook and line) and 29 million lb to sport fishermen. Competition between sport and commercial fishermen (and even between various types of commercial fisheries) has been severe and stimulated legislative attempts to control one type of fishing or another (e.g., make net fishing illegal, or declare the species a game fish which cannot be taken by commercial fishing). These proposals have been highly controversial and none has become law, but legal attempts for greater control undoubtedly will continue.

Yearly landings of king mackerel in Southwest Florida ranged from 1.2 million lb in 1972 to over 6 million lb in 1974, and averaged about 2.7 million lb. Seasonal catches are quite pronounced. Heaviest landings are usually in December through March whereas lowest landings are from June through September. The value of the 1980 catch of $1.8 million in Southwest Florida was less than half the total State value of $4.5 million.

King mackerel usually first spawn at ages three (males) and four (females) primarily from May to September. Spawning has been well documented off Texas and Northwest Florida, and from Florida to North Carolina along the Atlantic coast (Beaumariage 1973). Relatively little is known about the juveniles, which are seldom seen except for a few taken near shore in shrimp trawls. The adults may live 13 or 14 years but most are less than 7 years old. Adult mortality is estimated to be about 50% per year.

Tagging studies have shown extensive migrations. King mackerel tagged in winter along the Southeast Florida coast usually migrate into the Gulf of Mexico in spring and move as far west as Texas and eastern Mexico in the summer. A return migration in fall and winter has also been documented. Fish tagged in Southeast Florida have been caught as far north as Virginia. These and other continuing studies indicate that there are probably two populations of king mackerel with some evidence of mixing in the south Florida area.

Despite heavy exploitation of king mackerel, biological evidence indicated that the abundance of the species has remained relatively stable for many years (Beaumariage, personal communication).

The availability of the fish stocks sometimes change sharply because of their migratory habits and response to changing currents, climate, and other conditions. Whatever the cause, sport and commercial fishermen tend to blame each other when their catches are below their expectations.

Spanish Mackerel

The sport and commercial importance of the Spanish mackerel (Scomberomorus maculatus) is similar to that of the king mackerel, but it is smaller in size, and does not live as long (8 years). They first spawn at age group II over the inner continental shelf at depths of 40 to 165 ft from May through September (Powell 1975). Spawning has been documented from Cape Sable to offshore waters of Mobile Bay and from Georgia to Chesapeake Bay. Little is known about the juveniles, but they grow rapidly and enter the fishery at age one (second year of life), which is also the dominant age group of the catch. Migratory patterns are suspected to resemble those of king mackerel, but large scale tagging studies have not been attempted.

Spanish mackerel landings vary considerably from year to year in Florida waters. In 1970-80, Southwest Florida landings ranged from 1.1 million to 7.5 million lb annually, and statewide annual landings ranged from 6.4 million to 17.3 million lb. Catches are highest in October through April. Landings of 11.9 million lb in 1980 were valued at just over $3 million dockside.

Spotted Seatrout

The spotted seatrout (Cynoscion nebulosus) is highly sought by sport and commercial fishermen (Perret et al. 1980). Although there are no sport catch statistics, the sport catch probably equals or exceeds commercial landings. Commercial catch data are complicated by the large proportion of trout in the market that were caught by sport fishermen and sold. Some markets in Florida are heavily dependent upon sport catches to meet their demands.

Commercial landings of speckled trout in 1970-80 in Southwest Florida have been remarkably stable, ranging from 1.2 to 1.8 million lb annually and averaging 1.5 million lb--about half of the State total. The State's landed value in 1980 was almost $1.7 million, an average of 68¢ per lb. Landings were heaviest from October through January.

Commercial landings in 1951-76 declined markedly in some areas of Florida, possibly because of over fishing, but more likely because of the alteration of habitat. Examples are dredge and fill operations, pollution, low freshwater inflow into estuaries, and the conversion of wetlands to residential and industrial use.

The spotted seatrout is an estuarine-dependent fish that spends most of its life in estuaries. Some populations are so distinct that they exhibit different racial characteristics among major estuaries. Speckled seatrout spawn in the deeper waters of estuaries in spring and summer months in April-July. (In southern Florida some spawn year round.) Males first spawn when 1 to 2 years of age; females at 2 to 3 years of age. Adults may live to be 10 years old.

Striped Mullet

The black or striped mullet (Mugil cephalus) is one of five species of mullet in Florida and is the most important mullet commercially (Cato et al. 1976). Landings in Southwest Florida averaged about 16.6 million lb annually from 1970-80, and ranged from 15.9 to 20.1 million lb. Statewide landings

varied from 18.6 million lb in 1976 to 30.9 million lb in 1980. Monthly landings are highest from October through December and lowest in February, March, and April. The landed value in Southwest Florida in 1980 was $3.6 million, which was over half the total value of mullet landed in Florida.

Striped mullet spawn in offshore waters from October to January. Larvae have been collected from the Gulf of Mexico and the Atlantic coast as far north as Cape Cod, MA in depths to 900 fathoms. When 20 to 30 mm long, the larvae move into the estuaries and, except for spawning or seasonal movements to offshore waters, they probably live the remainder of their lives there.

Adults first spawn when 2 to 3 years old and females typically grow larger and live longer than males. Adult mullet sometimes inhabit fresh waters, and move long distances up rivers. Land-locked populations have been reported in Florida, Texas, and Oklahoma. Maximum age is 6 to 7 years, and maximum length is about 18 inches. Juvenile and adult striped mullet are primary consumers that feed largely on diatoms, algae, and benthic detritus. They have a muscular gizzard that helps grind their food.

Despite high production, striped mullet are probably under utilized. When fresh, it is ranked by some consumers to be one of Florida's finest eating fish, but because it is a relatively oily fish subject to early rancidity, it has an extremely short shelf life. Mullet are taken commercially primarily in the fall and early winter when they tend to school prior to moving offshore to overwinter and spawn. This strong seasonal availability is troublesome because the markets are glutted and prices fall. Currently, there also is a strong market in Japan for mullet roe. This relatively new demand has helped the fishing industry in Southwest Florida.

Pompano

Pompano (*Trachinotus carolinus*) has long been considered the aristocrat of Florida's fishes (Berry et al. 1967). Fishermen received as much as $2.70 per lb dockside in 1980. Catches in 1970-80 from Southwest Florida made up a majority of statewide landings. Annual production ranged from 1.4 million lb to 0.7 million lb and averaged about 942,000 lb.

The commercial catch is limited and most production is sold to restaurants. A closely related species, the permit (*Trachinotus falcatus*), also enters the catch and has potential for an expanded fishery. A brief description of the biology of the pompano is given in the following subsections.

Spawning. The exact location of spawning of pompano is unknown, but the appearance of larvae in offshore waters suggests offshore spawning. Ripe females have not been collected in inshore waters. The spawning season is apparently protracted, extending from April to October, and in some areas as early as February. Most spawning is from April through June.

Juveniles. Juveniles grow fast--about one inch per month. Preferred habitat of juveniles is open beach areas of the Gulf of Mexico and Atlantic coast where the bottom is predominantly sand and there is a diverse and abundant invertebrate fauna. The pompano is taken in large quantities in the surf zone where wave action uncovers food organisms. Pompano live in bays and estuaries and have a wide range of salinity tolerance.

Adults. The pompano is a relatively small fish, averaging 1 to 2 lb, but some reach 4 to 6 lb. Most pompano probably live to be 3 to 4 years old.

There are some indications that pompano migrate north in the spring and summer and return south in fall. Pompano command the highest price per pound of any fish in the southern United States; nearly 90% of total U.S. production comes from Florida waters.

Diet. Juveniles feed on a wide variety of organisms. Adults are more selective in their feeding and primarily consume coquinas and other mollusks.

Other Fish Species

Estuarine and marine fishes in Florida are used commercially for food, bait, oil, fish meal, and pet food. Commercial fishing for tarpon, bonefish, and sailfish is prohibited, but they are highly sought by sport fishermen. Annual fishing tournaments for these species are common.

The value of products of the commercial and sport fishery and their related or dependent industries or services (such as fuel, fishing equipment, boats, nets, ice, storage, and processing) must be considered before the total value of the fishery resources of Southwest Florida can be accurately established.

SHELLFISH

The most valuable coastal shellfish species sold in Florida markets are shrimp, lobster, blue crab, and stone crab. Of these, the most important are shrimp. In Southwest Florida, pink shrimp (*Penaeus duorarum*) makes up almost the entire catch although there are several closely related species that may occasionally be landed. Rock shrimp (*Sicyonia brevirostris*) is also produced and its importance grew considerably in the 1970's.

Landings of shrimp from Southwest Florida ranged from 15.7 million to 22.9 million lb from 1970-80 and generally represent over 50% of the total State landings. Because of the large volume and relatively high dockside prices, shrimp is Florida's most valuable commercial species (landed value over $41 million in 1980). The importance of the shrimp fishery of the Gulf of Mexico has been reported by Christmas and Etzold (1977) and for the south Atlantic United States by Eldredge and Goldstein (1975). A description of the biology of the pink and rock shrimps is given in the following subsections (Joyce 1965, Farfante 1969).

Pink and Rock Shrimp

Spawning. Pink shrimp spawn year-round at depths of 12 to 26 fathoms but most spawn in the spring and fall. Rock shrimp spawn at depths of 20 to 70 fathoms in winter and spring. About 500,000 fertilized eggs are released into the water column by each female. Females may spawn several times in one season.

Larvae. The larval stage is 15 to 30 days long depending upon the water temperature. Larvae remain in open waters until attaining the postlarval stage at which time they use tidal currents and salinity gradients to enter nursery areas. Pink shrimp use various portions of bays and tidal marshes for nursery areas whereas rock shrimp use higher salinity bays and nearshore areas out to depths of 10 fathoms.

Juveniles. Growth is rapid; they require only 3 to 4 months to mature. When water temperatures cool in the fall and the shrimp are 3 to 4 inches long, they emigrate from nursery areas using tidal currents for transport to offshore spawning grounds. Shrimp that do not emigrate may overwinter in deeper portions of bays until spring and then move offshore.

Adults. Major fishable concentrations of pink shrimp are along the southwest coast from Fort Myers to Tortugas. Major populations of rock shrimp live near Apalachicola Bay and from Cape Canaveral to Georgia, and to a lesser extent in the Tortugas area. Pink shrimp mature when about 3.5-4.0 inches long. They arrive in the offshore spawning grounds in fall and early winter when they are 6 to 8 months old and about legal size (47 whole shrimp per lb or 70 tails per lb). Maximum age is about 2 years, but few survive beyond 12 to 14 months.

Diet. The larvae are planktivores that feed on algae and zooplankton. Postlarvae, juveniles, and adults are omnivores, and feed on detritus and microorganisms.

Blue Crab

The blue crab (*Callinectes sapidus*) supports a major shellfish fishery in Southwest Florida and most are taken by traps (Adkins 1972). Baited longlines and dip nets have been used with some success, but they generally are too labor intensive.

The annual blue crab catch for Florida in 1970-80 averaged about 17.3 million lb of which less than 16% were caught in Southwest Florida. Monthly catches were generally heaviest from April through September. The landed value of the 15.6 million lb State catch in 1980 was about $3.5 million, and the dockside price was about $0.22 per lb (Prochaska et al. 1981). A brief description of the life history of the blue crab is given in the following subsections (Perry 1975, Van Engle 1958).

Spawning. Spawning is year-round except in northern waters of Florida when water temperatures sometimes drop below 60°F. Longshore migration on the west coast towards Apalachicola Bay by some females suggests this may be a primary spawning area for the Florida gulf coast. Females spawn at least twice, producing 700,000-2,000,000 eggs each time. Spawning usually peaks in April-June.

Larvae. The larval go through seven zoea stages lasting 31-49 days and one megalopa stage lasting 6-20 days. Zoea are planktonic until molting into the megalopa stage. Megalopa utilize tidal currents to move into estuarine waters where they molt into the first crab stage [2-3 mm carapace width (CW)].

Juveniles. Small blue crabs (<1.6 inches CW) live in a variety of shallow water habitats in the estuary (e.g., grass beds, muck bottoms) and gradually move to deeper water as they grow larger. Adult size (>120 mm) is achieved after 18-20 molts in 12-14 months.

Adults. The size range of adults usually is 4.7-5.5 inches CW; they enter the commercial fishery at 4.5 inches CW. Adult crabs are known to live at least one more year, and a few may live 3 to 4 years. Primarily a shallow-water species (<115 ft deep), adult blue crabs live in a variety of habitats ranging from gulf waters with 34 ppt salinity to inland freshwater rivers up to 121 mi from the coast.

Diet. Blue crabs eat fish, aquatic vegetation, mollusks, (clams, mussels, snails), crustaceans (amphipods, isopods), and insects and annelids. Little is known of the food habits of larval crabs, but laboratory-maintained animals have been successfully reared on photosynthetic dinoflagellates, brine shrimp (*Artemia*) and sea urchin eggs (*Arbacia*). The megalopa is omnivorous and will eat fish, shellfish, and aquatic plants.

Stone Crab

The stone crab (*Menippe mercenaria*) is another major Florida seafood delicacy, but only its claws are used for food. Because new claws may be regenerated, Florida law requires that stone crabs be released alive after legal-sized claws are removed.

Statewide stone crab landings increased steadily from 1970 (1.6 million lb) to 1980 (3.9 million lb). Southwest Florida catches dominated statewide landings and showed a similar increase. Stone crabs also are one of the five most valuable seafoods. In 1980, the average dockside price was $1.43 lb and the total value was over $5.5 million. A brief description of the life history of the stone crab is given in the following subsections (Sullivan 1979).

Spawning. Adults spawn throughout the year, but primarily from April through September. Most spawning females have a 2.25 inch carapace width (CW) and are approximately 2 years old. The number of eggs is believed to increase with the size of the female. Claws of legal size (3.5 inches minimum CW) are first produced at 3 years of age.

Larvae and juveniles. Stone crab larvae go through five zoea (planktonic) stages and one megalopa (benthic) stage. Juveniles develop within a month after hatching and first appear on shallow rock and shell substrates in late spring or early summer. Juvenile crabs have been found in all adult habitats.

Adults. Adults are benthic, burrowing animals. They live at depths up to 200 ft, but the fishery is largely confined to depths less than 100 ft. Although some inshore to offshore movement is associated with reproduction, no mass migrations have been reported. Males first enter the fishery as age group II in the fall and as age group III in the winter. Most females of the same age enter the fishery somewhat later. Most trapped crabs are 3 years old and possess two legal-sized claws. Crabs 4 and 5 years old contribute jumbo claws, and sometimes regenerated claws, to the fishery.

Diet. Larvae are plantivorous. Juveniles and adults are nocturnal carnivorous predators and scavengers.

Claw regeneration. Claws regain most (70%-80%) of their size after 2 molts. Claws regenerate to legal fishing size within 12 months. Over 20% of the legal-sized crabs trapped in a 1975-76 FDNR study had regenerating or regenerated claws, suggesting a heavily fished population and good survival rates of declawed crabs.

Management considerations. No trapping for stone crabs is allowed without a State (FDNR) permit; the crab season is closed between May 15 and October 15. Legal claw or claws (forearm 2.75 inches) may be taken, but live crabs must be released. A fishery management plan in effect for the Fishery Conservation Zone includes the above regulations as well as a boundary line to separate stone crab and shrimp fishermen in the spring. The boundary line is necessary to prevent territorial conflicts between the expanding stone crab and shrimp fisheries. The stone crab fishery is still increasing in intensity and production, but it may soon reach saturation, and new management decisions may have to be made. Research into the effects of dehydration on survival indicate that current fishing methods may not provide for maximum yield from the resource. Additional research must be done to determine whether current management practices need to be changed. Suggested changes in stone crab management have included various schemes for taking only one claw from a crab to enhance its survival and develop a new crusher claw. Information on claw regeneration and claw reversal indicates that declawed crabs survive adequately if not held out of water too long after being boated, and claw reversal is not frequent enough to increase the abundance of crusher claws.

Spiny Lobster

Spiny lobsters (*Panulirus argus*) are one of the most valuable seafood species landed in Florida (Gulf of Mexico and South Atlantic Fishing Management Councils 1981). In 1980 their value was $13.7 million dockside, and the average price was $2.10 per lb. Annual catches in the first half of the 1970's averaged over 10.3 million lb, but in 1975 the Bahama government prohibited Florida fishermen from lobster trapping in that island area. In 1975-80, annual catches in Florida ranged from 5.3 to 7.4 million lb and averaged only about 6.2 million lb. A brief description of the life history of the spiny lobster is given in the following subsections.

Reproduction. Mating, which involves deposition of an external spermatophoric mass ("tar") on the female thorax, is performed principally from March through July in the Florida Keys. During spawning, the female extrudes the eggs, passes them over the spermatophore where fertilization occurs, and attaches them to the underside of the abdomen. Eggs are carried by the female for 3-4 weeks, then they are released as larvae in waters bordering deep reefs adjacent to the Keys and Southwest Florida. They spawn from April through October, but predominantly in May through July. A female may carry from 300,000 to more than 1,000,000 eggs and spawn twice in a season.

Larvae. The spider-like phyllosome larvae pass through 12 planktonic stages in oceanic waters for about 8 to 9 months, then metamorphose to a transparent, swimming postlarval stage called a puerulus. The puerulus swims directionally until acceptable juvenile habitat is encountered, at which time

it settles out, molts, and begins juvenile development. Pueruli arrive predominantly during the new moon and first quarter (dark) phases of lunar months. In Florida, lobsters spawn year-round, but peak in the spring.

Juveniles. Growth of juvenile lobsters averages 3-5 mm per month until maturity (70-90 mm). Major estuaries (Biscayne Bay, Florida Bay) are the principal juvenile nursery areas for Southwest Florida's spiny lobster population. Juveniles initially take up residence in fouling assemblages or grass beds, aggregating in rocky dens as they attain sizes of about 35 mm CL (carapace length). As the juveniles grow, they move to deeper parts of the nursery area and migrate to seaward reefs when they near maturity (70-90 mm).

Adults. Most lobsters mature when 85-95 mm CL, and about 3+ years of age. A stable, unfished population consists principally of lobsters 100 mm CL or greater.

Diet. Larvae feed largely upon zooplankton, but pueruli are not known to feed. Juveniles and adults are omnivores, feeding principally upon mollusks and small crustaceans.

Predators. Larvae and postlarvae are eaten by pelagic fishes such as small tuna. Juveniles and adults are preyed upon by octopus and fishes, particularly groupers.

Management considerations. State laws specify fishing methods and practices (e.g., trap design and buoy markings) which include a minimum size of 76 mm (3 inches) CL and a closed season during the major spawning period (1 April through 24 July). A special two-day sport fishing season (20-21 July) is allowed. Sport bag limits are imposed during the regular and special fishing seasons.

Preparation of a Fishery Management Plan (FMP) for the South Atlantic and Gulf of Mexico Fishery Management Councils (promulgated by the latter) to regulate the spiny lobster fishery in the Fishery Conservation Zone is nearly complete and may become effective by FY 81-82. Management options selected for the FMP differ little from those already in effect in Florida.

The Florida spiny lobster fishery is currently overinvested in traps, boats, and fishermen. Recent estimates disclose that commercial production (4 million to 6 million lb annually) could be maintained with about one-third to one-fifth of the current fishing intensity.

The current illegal fishery for undersized lobsters ("shorts") may be 20% to 50% as large as the legal catch. Such practices undoubtably reduce potential landings.

Lobster growth is reduced by injury from sport and commercial fishing practices because some of the growth energy is redirected to regeneration. Reduction in lobster growth has been as great as 40% in areas where injury rates are high (e.g., juvenile nursery areas such as Biscayne Bay), delaying entry of juveniles into the fishery. Sport and commercial fishing sometimes is widespread in areas abundant with juvenile lobsters, and injuries of the juveniles probably reduce production potentials.

Escalation of trapping intensity has created demands that cannot be satisfied by supplies of traditional baits. Some fishermen have adopted the practice of baiting traps with live undersized lobsters. Because lobsters are gregarious, traps containing undersized lobsters will catch about three times more lobsters than empty traps or traps using other baits. The practice of transporting "shorts" aboard vessels to bait traps was allowed by State statute several years ago. The Florida Keys lobster fishery currently attempts to maintain more than 1 million shorts as bait in traps.

Recent FDNR research indicates that the practice of baiting traps with shorts may cause about 20% mortality. Mortality as high as 40% has been reported for bait lobsters held out of the water for 4 hours. Similar exposure-related mortality among shorts held in sorting boxes has been reported from western Australia. Holding in traps also leads to weight loss from starvation and may expose survivors to increased predator-related mortality (e.g., octopus). The practice of baiting with shorts in Florida may seriously reduce catch potentials.

The source of recruitment for Florida's spiny lobster stocks remains unproved. Several theories espouse either recruitment from local stocks or transport of larvae to Florida from Caribbean sources. The latter seems more likely considering the oceanic environment and length of time necessary to transit the larval period. Appropriate current patterns exist to accomplish such Caribbean transport. Extended spwawning periods in the Caribbean may explain year-round Florida recruitment. Finally, recent studies indicate spawning potential of the Florida population to be reduced 88% from that of a "natural" population, yet there is little indication of decline in recruitment to Florida stocks, as might occur if recruitment were dependent upon local spawning.

The Draft Environmental Impact Statement and Fishery Management Plan reports that potential Florida lobster landings should be twice as great as the 1980 landings. About 20% to 40% of this difference may be accounted for by unreported but legal commercial and sport landings.

Other Shellfish (Invertebrates)

In Southwest Florida blue crab, stone crab, pink shrimp, and rock shrimp make up over 95% of the total invertebrate catch. The only other invertebrate species taken are hard clams, bay and calico scallops, conchs, and sponges. Because of greater concern over the sponge fishery, less restrictive legislation has been proposed to aid in its recovery. The sponge industry had declined primarily because of competition with cheap plastic sponges but diseases, restrictive fishing regulations, and high costs of production contribute to increased rates. Members of the sponge industry believe that removal of some of the old non-biologically based laws will help restore the fishery.

Publications relevant to the Florida shellfish fishery and the biological characteristics of several species are in the list of references.

PROBLEMS OF RESEARCH AND DEVELOPMENT

THE STATUS OF RESEARCH

Before 1950, very little was known about the biology of the relatively few estuarine and marine fish and shellfish sought by sport and commercial fishermen. Following World War II, interest in fishing as a vocation and an avocation began to increase and with it the need to understand the life history of the more important species. In the 1950's and 1960's many papers were written about a variety of marine resource topics and collectively new biological concepts began to emerge. Most significant among the findings was that most coastal fish and shellfish are estuarine dependent. Studies revealed that at least part of the life cycle of over three-fourths of the major commercial and sport species along the coast of Florida depended upon the shallow estuarine areas (nursery grounds) where food and protection were abundant. The biological richness and importance of these nursery grounds were difficult to convey to the general public, and thousands of acres were lost to indiscriminate dredge and fill projects before protective legislation finally was passed.

Research, now more advanced and better funded, reflects even more the importance of estuaries for sustaining fish and shellfish. Some of the fishery research needs or requirements in Florida were reported by Cato (1979).

HABITAT ALTERATION

For the majority of fish species studied, the quantity and quality of habitat is a major limiting factor in species abundance. The alteration of habitat has been greatly reduced in Florida by protective regulations. No longer can developers move freely into marshes or estuarine areas and indiscrimately dredge and fill to create waterfront (canal) home sites such as Boca Ciega Bay, near St. Petersburg. Although dredging determined to be "in the public interest" continues, the massive projects of the 1950's and 1960's now are a rarity. Habitat loss today is more subtle; an acre or two, a small boat channel, a causeway, all of which have cumulative effects. Not only are estuarine areas being reduced, but the productivity of the remaining areas is declining. The decline in productivity is caused largely by the loss or diversion of freshwater inflow in estuaries and by municipal and industrial pollution.

The dependence of most coastal fish and shellfish on estuaries is clear evidence that increased coastal habitat protection is paramount. Some of the current water and land use changes and development practices that are still damaging to estuaries are (1) diversion of freshwater inflow from estuaries, (2) diking or impounding estuarine marshlands for mosquito control, (3) indiscriminate spraying of pesticides in or near estuaries, and (4) the construction of causeway, bridges, and other structures that seriously disrupt normal water current patterns.

Land management practices several miles upstream from brackish waters also may have serious effects on the estuarine habitat. For example, clear cutting can cause siltation and rapid salinity changes downstream that are

detrimental to an estuarine system. Agricultural pesticides, herbicides, and fertilizers may pollute downstream estuaries and damming, and altering of seasonal river flow may alter salinities in estuaries.

In view of man's destruction and alteration of estuaries, many possibilities for restoration have been examined. For example, a new spoil island or an eroding dune can be artificially vegetated to increase stability and establish a viable habitat. For essential projects where habitat destruction is unavoidable, mitigation may be required.

Under certain conditions, natural areas may be made more productive by the addition of new habitat features. For example, artificial fishing reefs on flat or low relief bottom areas have been shown to attract and concentrate fish so that they are more available to sport fishermen. The construction of shell reefs in appropriate waters may sharply increase the area for attachment of oyster spat and increase oyster abundance. Oysterbeds or reefs constructed by the Florida Department of Natural Resources in Apalachicola Bay since 1949 now account for a major portion of the oyster fishing grounds of Florida. This and other forms of restoration of lost or damaged habitat and even the improvement of natural estuarine areas have been made possible through extensive research and should be a prime consideration in marine resource management.

SPORT FISHERIES

The clear definition of a sport and a commercial fisherman is a debatable issue. There are, of course, commercial fishermen who fish for pleasure and sport fishermen who sell their catch. Both tend to seek the same species, sometimes in the same fishing grounds. Among the fishes that cannot be sold no matter how they are caught are sailfish, tarpon, snook, and bonefish. Almost all mullet and shrimp are taken commercially. Sport fishermen sometimes catch and sell fish caught with small seines, gill nets, and cast nets. For some species in Southwest Florida, the sport catch probably equals or exceeds the commercial catch.

In Florida, the economic value of the sport fisheries is considerable. There are now about 1/2 million registered boats, many of which are used by sport fishermen, and 36 million annual tourists, many of whom go sport fishing. Major sport fishes are king and spanish mackerel, grouper, red snapper, spotted seatrout, redfish, cobia, flounder, and whiting somewhat in that order. Large numbers of other species also are caught. For example, a year long creel census in Choctawhatchee Bay (Irby 1974) showed that although speckled seatrout was one of the most popularly sought fish, fishermen actually landed more pin fish. In Choctawhatchee Bay, party and charter boat fishing accounted for 50% of the fishermen and 75% of the sport catch, whereas bay sport fishing from private boats, piers, and shore accounted for only 35% of the sport fishermen and 16.4% of the catch. Tourists comprised 95% of the fishermen using party and charter boats. In Southwest Florida, a large number of fishing tournaments are conducted annually. Some tournaments sponsor competition for catches of sailfish, tarpon, and sharks. Fishing contests for sport fish are common along the Florida coast.

THE BAIT INDUSTRY

The great increase in sport and commercial fishing since about 1950 has created a great demand for natural bait. Almost any fish species can be cut up and used for bait, but only a few enter the trade in large quantities. Favorite baits are squid, shrimp, silver mullet, ballyhoo, halfbeaks, herrings, and small jacks such as cigar minnows and goggle eyes. With the exception of shrimp, most of the bait sold is frozen or fresh dead. Silver mullet, ballyhoo, and some of the herring species are usually sold whole, especially those prepared for sailfish, billfish, and king mackerel fishing. The majority are sold to party and charter boat anglers and the success of the trip often depends on the availability of the proper bait.

The most valuable and useful bait is live shrimp. Live bait shrimp are caught primarily in estuaries where food shrimp fishing is banned. Part of the justification for this leniency is the self-limiting nature of the bait fishery. For shrimp to be kept alive, the vessel must be equipped with recirculating water holding tanks and a small shrimp trawl that is towed for only a short time (10 min). Short hauls with small trawls help keep shrimp mortality at low levels and reduce the catch of other fishes.

MARICULTURE

Mariculture is the commercial cultivation of estuarine or marine fish or shellfish. The high reproductive potential of most species and the increasing value of most seafoods has drawn much attention to the possiblity of "farming the sea." Most of the mariculture experiments in Florida used pompano, freshwater shrimp (Macrobrachium), and saltwater shrimp (Penaeus).

Several attempts have been made to raise saltwater shrimp. One company invested several million dollars and produced several hundred thousand pounds of shrimp in a year. Although this production was insufficient for reasonable profit, experimental culture is still underway. Their greatest success was achieved in two 300-acre ponds in which the cultured postlarval shrimp were stocked and fed until they were of harvestable size. In earlier years, shrimp mariculture was attempted in 2,500 acres of fenced bay bottom, which required the first State "mariculture" lease. A continuing series of problems ranging from hurricanes and high tides, to nets that sunk from an accumulation of fouling organisms (such as barnacles) forced them to abandon this method.

Despite these and other experiments, mariculture in Florida is still in the developmental stage. Major problems were the high cost of labor and land, low winter water temperatures, and biological problems associated with mass culture. The most successful mariculture projects in Florida were moved to Central or South America where these problems are less troublesome. One of the better potentials for mariculture in Florida is in saltwater aquaria culture. Since some of the brightly colored reef fishes now sell for as much as $50 each, their culture could be highly profitable. However, the high prices are an artifact of their scarcity and a successful culture effort will result in a great decrease in price. This in turn brings the cost within the range of many more aquarium enthusiasts. In summary, there is potential (as there is in several species), but a successful effort will be long term, well funded, and not directed toward quick returns.

RESOURCE CONCERNS AND ISSUES

FLUCTUATIONS IN CATCH

One of the long-established characteristics of estuarine or marine fish is their fluctuating abundance. Despite many years of study, there is little information that points to the cause. There is speculation that unusual weather changes may be partially responsible. Unusually low water temperatures may cause high mortality among estuarine fishes. Low freshwater inflow may cause excessive salinity in estuaries and poor reproduction. Low salinities after major floods may produce the same results.

Little is known about fish and shellfish abundance except relative measures reflected by commercial and sport catches. For Southwest Florida, sport catch data are scarce and the only commercial catch statistics available are those collected by the National Marine Fisheries Service. Changes in commercial catches require careful analysis. For example, when statistics show a decline in production for several years, it does not necessarily reflect an actual decline in the abundance of the species. The decline may simply reflect a change in fishing intensity or some other cause, but catastrophic declines or long-term trends usually become clearly apparent.

THE SHRIMP INDUSTRY

The abundance of shrimp stocks (based on commercial landings) in Southwest Florida has been high in recent years. Although generally it is probably not possible to overfish shrimp, the loss or alteration of the estuarine nursery grounds is a sizeable threat to future production.

Economics is the major problem currently confronting the shrimp industry. Fuel costs have risen rapidly over the last several years and imported shrimp constitute continuing competition, particularly those from Mexico where fuel costs of production are lower. Because of the high price for shrimp, which usually exceeds the price of red meat, almost 80% of all shrimp is sold to restaurants.

These economic problems are creating demands for limited entry which would reduce the number of shrimpers (which now greatly exceeds the number of necessary to catch the available shrimp) and increase individual catches and profits. Limited entry and other controls would require major legislation. In some states where limited entry is in effect, the method has not always been helpful. It often creates as many problems as it solves. If limited entry is not established for the shrimp industry, the results may be the same because without some assistance, many of the smaller boat owners will be forced out of business which would reduce the number of boats in the fishery. Opponents of this "laissez faire" method feel that the shrimp industry will be severely damaged. In addition, once the industry stabilizes again, and becomes profitable, more ships will re-enter the fishery and the cycle will start over again. Most commercial fishermen appear to favor limited entry, but usually only when they think it will not affect them. In many limited entry proposals, there is a grandfather clause allowing anyone already in the industry to continue to fish. In effect such a scheme would only stop "new"

shrimpers from getting started. Since there are probably already many more vessels than necessary to catch available stocks, a grandfathered limited entry would not provide immediate relief, but it might be the long-term solution.

Another major problem of the beleaguered shrimpers is the incidental catch of threatened and endangered species of marine turtles. Turtles are caught in shrimp trawls during normal fishing operations and are killed if held underwater by the net long enough. Emotion over this problem is so great that some people and agencies have suggested that the shrimp industry should be closed down. The shrimp industry is taking steps to keep the mortality at a minimum. The shrimpers have agreed that trawling time will not exceed 90 minutes per drag in areas where turtles are abundant. The National Marine Fisheries Service is experimenting on net designs that usually will not catch turtles. Recent designs in the excluder trawl look very promising and large scale testing is planned. These nets have other advantages as well. By excluding large amounts of trash and other debris of unwanted species (such as some types of jellyfish and fish too small to sell) they reduce drag, increase catch, and perhaps save fuel.

In summary, the shrimp fishery is the most valuable fishery in Florida yet it is confronted with economic problems that threaten almost all industries. A regional management plan for the shrimp fishing of the Gulf of Mexico, United States, was reported by Christmas and Etzold (1977).

LEGISLATION AND COOPERATIVE ACTION

The Fishery Conservation and Management Act of 1976 (Public Law 94-265), which extended United States jurisdiction of fisheries from the territorial sea out to 200 miles, is probably the most far reaching fishery regulation of this century. To accomplish its purpose, eight Regional Fisheries Management Councils were formed and these quasi Federal agencies were given the responsibility for developing fishery management plans for those fish species that live primarily from the outer boundary of the territorial sea to 200 miles offshore (Fishery Conservation Zone FCZ). The law gives U.S. fishermen first rights over all fishing stock in the zone. Foreign fishing is permitted by the councils only when they determine that a surplus exists beyond that which U.S. fishermen can catch.

Although Florida is a member of two councils (the South Atlantic Fishery Management Council and the Gulf of Mexico Fishery Management Council), Southwest Florida Fishery Conservation Zone is under the gulf council, which has enacted or is working on fishery management plans for the following fish and shellfish: stone crabs; shrimp (white, pink, brown, and related species); reef fish (snappers, groupers, and related species); king and spanish mackerel (cooperative plan with South Atlantic Council); spiny lobster (cooperative plan); groundfish (primarily species taken incidental to shrimp trawling); sharks; coral (cooperative plan); and bill fish (a four-way cooperative plan with South Atlantic, New England, and Caribbean councils).

Central to the development and approval of fishery management plans are the Seven National Standards that the act requires must be met. They are as follows:

1. Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery.

2. Conservation and management measures shall be based on the best scientific information available.

3. To the extent practicable, an individual stock of fish shall be managed as a unit throughout its range, and interrelated stocks of fish shall be managed as a unit or in close coordination.

4. Conservation and management measures shall not discriminate between residents of different states. If it becomes necessary to allocate or assign fishing privileges among various U.S. fishermen, such allocation shall be (A) fair and equitable to all such fishermen; (B) reasonably calculated to promote conservation; and (C) carried out in such a manner that no particular individual, corporation, or other entity acquires an excessive share of such privileges.

5. Conservation and management measures shall, where practicable, promote efficiency in the utilization of fishery resources; except that no such measure shall have economic allocation as its sole purpose.

6. Conservation and management measures shall take into account and allow for variations among, and contingencies in, fisheries, fishery resources, and catches.

7. Conservation and management measures shall, where practicable, minimize costs and avoid unnecessary duplication.

In addition to protecting and providing for proper utilization of fishes beyond the territorial sea, this act may profoundly affect inshore fisheries as well. As fishery management plans are approved and the results (both successes and failures) are available for review, the potential exists for individual states to enact similar regulations that may better protect their own fisheries.

Success of the act will depend on how well the councils are able to deal with particularly difficult issues such as limited entry, pre-emption of a state's fishery regulations, and allocation of limited or diminishing resources. PL 94-265 has the potential for assuring maximum/optimum sustained yield of our country's marine fishery resources.

FEDERAL FUNDING

Federal support for fishery development and research in Florida has never been great. In contrast to the Northwest Pacific Coast states, (which favor salmon), Federal aid in the Gulf of Mexico has never been in proportion to fishery production in Southwest Florida. Probably the most beneficial Federal

aid has been provided through Public Law 88-309, "The Commercial Fisheries Research and Development Act of 1964." It has provided research and marketing funds on a matching basis through the Florida Department of Natural Resources. These funds have been responsible for accelerated research and for the development of the largest seafood marketing program in the Southeastern United States. Florida's share of PL 88-309 was $240,000 in 1980.

The Anadromous Fisheries Research and Development Act (PL 89-304) was designed primarily for northwestern states with strong anadromous fishery resources such as salmon. Benefits to southern and Gulf states were reduced because anadromous species there are scarce. Florida received 89-304 funds for studies of Alabama shad and sturgeon, which do not occur in Southwest Florida.

The Fishery Conservation and Management Act of 1976 (PL 94-265 already discussed) also provides funds for fishery resource and development. The individual fishery councils of the Gulf of Mexico may contract state or private organizations for needed research. Although council funds for such outside work are limited, they do not require matching funds.

Funds for marine fishery development also are available from Saltonstall-Kennedy funds (SK), that are derived from an excise tax on imported seafood products. In past years, these funds have been used sparingly, but funds were made available to aid the seafood marketing and other industry oriented programs.

Another major Federal program affecting marine resources is the National Sea Grant Program. In Florida, it is based at the University of Florida in Gainesville, but it is a consortium of State and private universities, each applying for funds to do research pertinent to marine resources. The programs in Florida have been highly successful in a number of areas particularly in fishery economics. The grant program also has established a statewide network of marine extension agents designed to help fishermen, as county agents help farmers.

The Coastal Zone Management Act of 1976 also represents a potential source of Federal funds that may be used in a variety of ways and could strongly benefit coastal living resources. A prime accomplishment in Southwest Florida connected with this program was the designation of the Rookery Bay Estuarine Sanctuary. This designation provided funding for the purchase of additional lands crucial to protecting the environmental integrity of the system, as well as funding for the first 3 years of operation of a sanctuary office. In the case of the Apalachicola Sanctuary, these lands, when purchased, will be added to several thousand acres already purchased by the State for the same purpose. The designation will also make it very difficult to make any alterations that might negatively affect the system. The coastal management program also has been designated by the Reagan administration for deletion and the current status of any future funding appears bleak.

CZMA also releases funds to help endangered species projects and studies on marine species or habitats. The National Science Foundation issues grants on fishery and coastal environments.

REGULATORY PROBLEMS

Florida's marine fishery resources currently are regulated by the State legislature. The Florida Department of Natural Resources has rule-making authority, but only to clarify the legislation and establish ways and means for enforcing the regulations. The advantage of a legislated regulatory authority is that any new law requires approval by the House and Senate and the governor. This procedure serves to relieve political pressure on the Department and allows it to avoid making a long-term decision in the heat of a confrontation. The disadvantage is that it does not always work that way. Far too many laws still are enacted in the heat of confrontation and many are controversial and ineffective.

In summary, resource laws should be based on the resource needs, not on the votes of any special interest groups. This requires good biological judgment and data and an ability to avoid the power of pressure politics. Florida's law says that the marine resources are to be managed for the benefit of all citizens. That should include sport fishermen, commercial fishermen, and seafood consumers alike. When the resource is shown scientifically to be in jeopardy, then all resource users should share the burden of restoring the resource. The Seven National Standards quoted earlier represent the Federal attempt to ensure these rights to all fishermen in the FCZ; perhaps Florida needs a national "Standards" for State legislation as well.

Florida also has "local laws." These laws that govern fisheries may apply only to one county or legislative district and are not necessarily consistent with other laws based on biological principles or evidence. Partly in response to this problem, the Florida Legislature passed an act in 1980 that established a Saltwater Study and Advisory Council to review all fishery management needs and problems and to establish criteria and guidelines for such management. The work of the Council is extremely important to the citizenry of Florida and the results of their work were completed in 1982.

Industry Concerns

Numerous problems confront the fishing industry. The cost of fuel is causing serious concern. The scarcity and high cost of fuel is a continuing consideration among fishermen. Although expensive, current supplies of fuel are fully adequate, but an allocation system may be necessary in the future. Currently, most fishermen feel they will be given preference for fuel on the same basis as farmers; this has relieved some concern. Gasoline and sales tax exemptions and fuel allocation procedures, as a relief for commercial fishermen, was reported by Cato (1973).

Direct Federal assistance to members of the fishing industry has been small although general assistance, such as the use of Saltonstall-Kennedy funds for marketing programs, has been helpful. The most recent example of Federal assistance to the fishing industry of Southwest Florida was the aid made available to members of the lobster industry when Bahamian waters were closed to U.S. fishermen.

Some Federal assistance is also available through the Small Business Administration (SBA) and other similar agencies for low cost loans. These are

loans, however, and must be paid back with interest. The advantage of such loans is their availability and lower interest rate.

The licensing of commercial fishermen currently is not required in Florida despite 5 years of attempts by commercial fishing organizations to pass self-licensing regulations. Such a license would better identify full-time and part-time commercial fishermen and would provide a revenue that might be directed toward the solution of problems in the fishing industry such as quality control.

QUALITY CONTROL AND MARKETING

Quality control is a serious concern of the industry and increasingly strict regulations designed to protect the public health add to the cost of seafood products.

Although quality control codes generally are enforced by several State and Federal agencies, enforcement often is inadequate. Some of the more progressive fishery companies employ their own quality control standards to assure safe and high quality products.

Although Florida boasts some of the largest and most modern seafood plants in the Southeastern United States, a large portion of the fishing industry consists of small operations. To increase fishery production and to extend the markets more for underutilized species, an extensive marketing-consumer promotion is required that is beyond the capacity of most members of the fishing industry. To meet this need, the State of Florida has established a seafood marketing-extension program supported by the industry through a self-imposed production tax, Federal matching money, and State revenues. This program emphasizes underutilized species. A new species source brings several benefits. The development of new fisheries and new fish products often divert fishing from traditional fisheries and reduce fishing intensity there. The fish will sell at a lower price and more people will be hired by the industry. One of the best examples is rock shrimp. Prior to an extensive marketing and educational program, rock shrimp in the catches usually were discarded. Now rock shrimp support a multimillion dollar fishery.

Marketing successes in Florida led to the establishment of out-of-state offices funded by the seafood and marketing extension program, and funds and assistance from the Coastal Plains Regional Commission, National Marine Fisheries Service, and the Gulf and South Atlantic Fishery Development Foundation. Their cooperative actions also have supported extensive seafood promotion in the midwest. More recently international marketing of Florida and southeastern U.S. seafood products has been highly successful and may possibly lead to the establishment of a cooperative European office under the auspices of some State or Federal agency.

Limited Entry

The production of some fish and shellfish appears to be at or near maximum sustained yield and has been for many years, but rapidly rising prices have stimulated increasing competition for fish and individual catches and profits have declined. In most fisheries, there are more fishing vessels and

fishermen than are actually needed for optimum or maximum production. Because of this excess, the idea of limited entry is receiving extensive discussion in Florida and already has been initiated in some states.

Limited entry is defined as limiting the number of fishermen or fishing boats in a fishery. The object is to conserve fish stocks, increase the income of individual fishermen, and possibly reduce market prices. The only limited entry in Florida is directed toward eventual elimination of the food shrimp fishery in the St. Johns River. Food shrimp production is illegal there without a permit, and only those holding permits can renew them. Since permits are invalidated when the holder dies or discontinues fishing, the number of permits eventually will decline to zero. So far the number of permits has declined from about 650 to about 130.

The lobster fishery is being considered for limited entry. The Rosenstiel Institute of Marine and Atmospheric Science of the University of Miami in cooperation with the Florida Department of Natural Resources, under a Ford Foundation Grant, evaluated economic advantages and disadvantages of limited entry for lobsters. The study did not recommend limited entry (Austin 1978).

Limited entry sometimes can best be justified when the abundance of the resource is diminished by excessive fishing. Limited entry for economic reasons (i.e., to increase the profits of the fishermen) is not generally highly regarded. Number 5 of the Seven National Standards under PL 94-265 for the Fishery Management Plans in the Fishery Conservation Zone is a serious obstacle to economic allocation. Reluctance is expressed by those who believe that the free enterprise system will solve the problem because if the catch is divided among more and more fishermen and their profits decline, some will eventually leave the industry (intentionally or through bankruptcy). The best fishermen will survive and profit. If this happens before the population is seriously depleted, a "limited entry" will have been achieved without government control. This condition is only a temporary advantage because as soon as the fishery becomes profitable again, more vessels will start fishing and the cycle is repeated. For example, recent studies by economists Cato and Prochaska of the University of Florida, have shown that for every 10 cent increase in the price of a pound of shrimp, approximately 200 more boats enter the fishery.

Limited entry workshops were held in Denver, Colorado in 1978 and Jacksonville, Florida in June 1981. In general, those conferences concluded that limited entry was but one tool for fisheries management and that although there might be instances where its use would be appropriate and effective, it is not a panacea and it would probably best serve as a last consideration.

Another concern of the fishing industry is the competition between sport fishermen (particularly those who sell their catch) and commercial fishermen (particularly those with larger and more sophisticated equipment) for the same stock of fish. For some species, the sport catch often equals or exceeds that of the commercial fishermen (e.g., king mackerel and speckled trout). The competition is greatest in bays and estuaries where small boats are seaworthy. Because of the political influence of sport fishing interests, commercial fishing has been eliminated or severely restricted in some areas. Some commercial fishermen fear that if this trend continues, the effect could be to slowly legislate commercial fishermen out of the business in nearshore coastal

waters and estuaries. To avoid this, the commercial fishing lobby is strengthening its position on these matters.

The conflict between sport and commercial fishing is unfortunate because they share common problems (lower catches) for the same reasons (loss of natural habitat and consequent reduction in abundance). A concerted effort by both groups, directed at the real problems would be more effective.

DATA GAPS

Despite decades of scientific research on marine and estuarine-dependent fishes, detailed information on the life history, abundance, and distribution of many species is relatively scarce. Although there are many data gaps on how fish species live and interact with each other and their environment, the major data gap is the lack of reliable sport and commercial catch statistics. Commercial landing statistics gathered by the National Marine Fisheries Service are helpful, but the data generally are insufficient for the needs of today's fishing management requirements. Reliable or useful data on sport fish catches is virtually nonexistent. Nationwide sport fishing surveys by the National Marine Fisheries Service provide about the only data available. Reliable and timely catch statistics for fishing mortality analysis must be available before some of the most basic fishery management questions can be answered.

Although Federal and some State funds have been provided for sport fishing surveys (Florida in 1980 contributed $100,000 to the National Marine Fisheries Service to increase the number of Florida interviews in an effort to achieve better accuracy), their continued funding is also in question because of fiscal constraints. Some surveys such as mail questionnaires, are subject to major, innate weaknesses, such as reliance upon information "remembered" by fishermen. These mail surveys are complex and difficult because the total population is sampled rather than only fishermen. A sport fisherman list is possible only if the fishermen are licensed. The best technique may be to count and interview during or just after fishing.

Because of the critical need for catch statistics and the scarcity of funds for such surveys, licensing of sport and commercial fishing may be considered. Proponents say that a sport and commercial license would at least identify all the fishermen (making surveys more efficient), and provide a roster that could be used in fishermen surveys. Opponents simply feel it is another unnecessary tax. The commercial license has been strongly supported in Florida by the commercial industry for several years, but it has been extremely controversial despite the three major national recreational fishery organizations that are strongly in favor of it. A general feeling in the State and Federal governments is that the resource users should bear the brunt of costs related to that resource. As governmental funds begin to decline, the public attitudes toward a sport license may change as well. A proper license would be inexpensive, yet it would provide funds and information long needed for effective marine resource management.

Coastal habitat is necessary for producing marine resources, yet we know little of how much there is, how much has been altered, and how much of that

remaining has been adversely affected by man's alterations or threatened by it. This deficiency is a major data gap. Documentation of habitat loss will be time consuming and expensive. Satellite imagery is a relatively new tool, but one which can, by comparing old and new aerial photographs, identify habitat change. This information will be beneficial in documenting not only the importance of habitats in general, but also in evaluating any new or proposed action that will result in habitat loss or alteration. It may identify areas where restoration will be most beneficial.

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MULTIPLE-USE CONFLICTS

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INTRODUCTION

Southwest Florida, consisting of ten coastal counties, contains numerous bays, estuaries, and wetlands, and hundreds of miles of relatively unspoiled sandy beaches. Among these natural resources are the major population centers of Tampa, St. Petersburg, Clearwater, Sarasota, Bradenton, and Fort Myers. Southwest Florida has been and is growing rapidly, particularly in metropolitan areas. As the population increases, socioeconomic/environmental conflicts associated with this growth become more and more troublesome.

In view of the conflicts common to rapidly growing relatively affluent areas as described in this report, it is prudent to protect and manage Florida's natural coastal resources through long-term planning to help minimize serious conflicts, alterations, or losses. The real problem is paradoxical, i.e., to keep the expanding population from excessively desecrating, defacing, scarring, or polluting the highly valued environmental characteristics and natural resources that attracted them there.

This paper focuses on conflicts that arise from competing uses for land and resources. It gives a brief history of land development in the State and in Southwest Florida and discusses current multiple-use conflicts. An overview of the legal and institutional constraints on development is given and a major section is devoted to environmental and socioeconomic conflicts on Rookery Bay and Marco Island, Charlotte Harbor, the Big Cypress area, the Florida Keys, and Sanibel, a major barrier island.

BASIS FOR CONFLICT

The following is a list of socioeconomic and environmentally oriented problems and conflicts that relate to Southwest Florida.

- The economy of Southwest Florida is heavily dependent on tourism and the beauty of the water and beaches. Anything that threatens these resources threatens the economy of the region.

- The intensity of the demand and competition for residential, recreational, industrial, and commercial development of coastal lands and waters, and the concerns of the environmentalists, are the basis for multiple-use conflicts in Southwest Florida.

- Residential areas are frequently developed with little regard for potential hurricanes and associated floods.

- Coastal wetlands and estuaries are vital to Florida's commercial and sport fishing industries, but these resources are usually ignored by planners and developers.

- New or expanding coastal residential and industrial development will further compound the problem of rapidly diminishing coastal land and water resources.

- Reduced groundwater supplies and accelerated runoff from rainfall are symptoms of major changes in land use (e.g., displacement by streets and buildings).

- Excessive use of groundwater supplies for municipal use or from individual wells may cause a shortage of freshwater, and invite saltwater intrusion.

- The construction of housing, roads, bridges, piers, and jetties on barrier islands is certain to destabilize the beach environment.

- Extensive new onshore industrial developments may cause fiscal problems for local governments. During first construction, local governments may be confronted with tax deficits created by the increased population and demand for public services prior to any increase in property tax revenue. In the long run, economic gains from increased property tax revenues are likely to more than compensate for early financial deficits.

- Sewage disposal in new, and sometimes even old residential areas may cause serious public health and environmental problems. Faulty septic tank systems could cause seepage of contaminated wastes into the ground water and in some coastal waters.

- Wetlands may be filled in or covered to provide onshore urban facilities, which results in a loss of essential food and shelter for coastal fish and wildlife and a loss of natural storage of flood waters.

- Contaminants and wastes discharged by industry may pollute the water and endanger aquatic organisms and human health.

- Potential Outer Continental Shelf (OCS) oil and gas production in the eastern gulf, if extensive and without adequate consideration for the environment, could in some areas seriously damage or destroy estuaries, marshes, beaches, and fish and wildlife populations.

- o Oil and gas pipelines built on wetlands could increase open water areas, destroy emergent vegetation, increase sedimentation and turbidity, and cause serious concern for the disposition of the spoil.

- o Water may be polluted by dredge and fill practices, offshore construction of platforms, and discharges of clays and drilling liquids and wastes during drilling.

GENERAL RESOURCE CHARACTERISTICS

COASTAL ESTUARIES AND WETLANDS

Southwest Florida's rich natural resources provide a wide spectrum of environmental, economic, and social benefits. Its bays, estuaries, wetlands, and beaches are subject to intense residential, industrial, and recreational developments that usually are associated with rapid increases in population. Considering these developments, particular attention must be given to natural systems, freshwater recharge, optimal water quality, coastal integrity, and biological productivity.

The coastal wetlands of Southwest Florida have many socioeconomic values. The major ones are listed below.

1. Coastal wetlands provide a buffer against storm sturge and flood damage by dissipating wave energy and storing flood waters. Barrier islands also serve as natural buffers, protecting mainland areas from the full force of storms.

2. Wetlands function as natural water filters, serving to maintain water quality and to reduce adverse effects of urban and agricultural runoff. They are particularly efficient in absorbing and filtering out sediments, particulates, nutrients, and organic materials.

3. Coastal estuaries, fed by freshwater rivers, provide productive natural habitats, breeding and nursery grounds, cover, and food supplies for a vast array of fish and wildlife.

4. Coastal estuaries and contributing rivers are essential for sustaining Southwest Florida's highly valued commercial and sport fisheries. According to recent studies, about 80% of the income from Florida's Gulf of Mexico fisheries is from estuarine dependent species; consequently, maintaining wetlands, estuaries, and nearshore waters is of high priority.

5. Coastal wetlands serve as a reservoir to store water, to recharge groundwater aquifers, and to provide hydrostatic head that protects groundwater supplies from saltwater intrusion.

RECREATION, TOURISM, AND INDUSTRY

The recreational value of Southwest Florida is of considerable economic and social importance. Tourism is the leading industry in Florida, and the

gulf coast is one of Southwest Florida's major tourist attractions. The beaches and related facilities play a major role in the economy throughout the year, especially in the winter.

Coastal waters and major tributaries provide routes for waterborne transportation of goods and supplies, such as oil and agricultural products. They also provide sites for ports and harbors, and for other economic activities that rely on coastal resources. The coast is a primary site for large electric generating facilities, and in some areas it supplies an abundance of sand, shells, and oil and gas.

OCS OIL AND GAS

Offshore oil and gas development, deepwater ports, processing and shipping of petroleum products, and other OCS-related activities potentially could have major environmental, economic, and social impacts on Southwest Florida's coastal wetlands, natural resources, and communities. A major environmental threat is the potential for oil spills during drilling and transporting of oil. A major oil spill could be devastating because of the coast's vulnerable environment and its heavy reliance on its beaches for tourism. Intensive OCS exploration and development usually generates new onshore activity that causes additional environmental, economic, and social impacts (either beneficial or detrimental). These impacts are discussed in the chapter on Mineral and Oil Resources.

ECONOMIC DEVELOPMENT AND COMPETITION FOR LAND AND WATER

LAND AND WATER DEVELOPMENT

Historical Background

Florida was acquired by the United States Government from Spain in 1821, but was not granted statehood until 1845 when its population was about 55,000. Upon statehood Florida received title to very little land, only 202,000 ha (500,000 acres) for internal improvement purposes, and one section (259 ha or 640 acres) in every township for education purposes. The state did, however, become owner and trustee of the bottoms of all navigable waters.

It was not until 1850 that the State gained title to 8.3 million ha (20.5 million acres) of swamp and overflow land. The remaining land stayed in Federal ownership or was conveyed directly to individuals by the Federal Government.

An early goal of the State and the Internal Improvement Board (created in 1851) was to encourage internal improvement. The primary tool for achieving this goal was by disposing of land, its most plentiful commodity. In the late 1800's the railroads received approximately one-third of the land or 4.45 million ha (11 million acres) in exchange for laying 1,800 km (1,100 mi) of track, an average 4,047 ha (10,000 acres) per mile of track (Landers 1975).

Swamp and overflow land also was similarly disposed of by the State. By the end of the Civil War, several railroad companies that had built lines into Florida were bankrupt or otherwise disbanded, and their property reverted to the State. The Internal Improvement Board underwent financial hardship as a result and was forced into receivership. To solve this problem, the State sold 1.6 million ha (4 million acres) of Southwest Florida land to Hamilton Disston of Philadelphia for one million dollars (25 cents per acre).

In the latter half of the 19th century, Florida remained largely untouched and out of the way of national development. The land was inexpensive, but it was also swampy and poorly served by transportation. By 1900, the State had about half a million residents, most of whom lived in the northern part of the State.

Shortly after the beginning of the 20th century, practical methods were devised for filling submerged land. The State immediately began disposing of its submerged land and the rush of development that began then shows no signs of slowing today.

Population Growth

The population of Florida grew from 55,000 in 1845 to almost 10 million in 1980, and it continues to increase at an average rate of about 7,000 people per week. Sand dunes have been leveled, bays have been polluted, estuaries have been dredged and filled, rivers have been channelized, and the State has increasingly had to cope with multiple-use problems of development. A recent feature article in Sports Illustrated (January 1981) has gained some notoriety in Tallahassee and the rest of the State. The title of the article, "There's Trouble in Paradise," gives an indication of its tone. According to the authors, "in no state is the environment being wrecked faster and on a larger scale" (Boylé and Mechem 1981). Although the article is largely an editorial statement and subject to dispute, it does emphasize the socioeconomic and environmental problems confronting Florida as a result of urban development, and clearly illustrates many types of multiple-use conflicts.

A number of major developments have taken place in Southwest Florida over the past several decades. Perhaps the most significant one has been the subdivision of wetlands for residential development to accommodate the rapidly growing population.

Development has been especially intense near the coast where growth is the most environmentally damaging. Subdivision expansion into wetlands has been especially acute in Lee, Collier, and Charlotte Counties.

Current Status

Florida's past experience has shown that the allocation of land and water resources often provides short-term losses to the public as a whole. In recent years the State has recognized that large water-related coastal projects often have major adverse environmental effects and is attempting to develop several approaches to minimize the damage. The ongoing, rapid development of the State and Southwest Florida continues to create conflicts among the many competing uses for the land and water resources.

LEGAL AND INSTITUTIONAL FACTORS

Several laws and programs relate to multiple-use conflicts in Florida. This section gives an overview of the State's Coastal Management Program, the Environmental Land and Water Management Act (particularly the sections on Developments of Regional Impact, and Areas of Critical Concern), industrial siting and environmental permits that affect industry, and the Coastal Construction Control Line Program. A more thorough discussion of environmental legislation is in the Chapter on "Environmental Issues and Regulations."

COASTAL ZONE MANAGEMENT PROGRAM

The Coastal Zone Management Act of 1972 (PL 92-583) was adopted by the U.S. Congress as a means of protecting and enhancing the Nation's coasts by helping the states develop and implement programs for managing their coastal areas. Florida has received grants for developing its management program, and has recently finalized its program (Florida Department of Environmental Regulation 1980).

Florida's coastal zone management program dates back to 1970 when the Coastal Coordinating Council was established. The council members and staff worked with coastal planning until 1975 when the council was abolished by the legislature and its duties and functions were transferred to the Department of Natural Resources. Among the notable works by the council staff was the preparation of a massive coastal atlas and the identification of coastal lands suitable for either habitat preservation, fish and wildlife conservation, or urban/industrial development (Florida Coastal Coordinating Council 1974).

In 1977, the legislature transferred the powers and duties of coastal management to the Department of Environmental Regulation. The legislature acted to strengthen coastal management in 1978 with passage of the Florida Coastal Management Act (ch. 380.19 F.S.). The enabling legislation states that "... the environmental aspects of the coastal areas of this state have attracted a high percentage of permanent population and visitors and that this concentration of people and their requirements has had a serious impact on the natural surroundings."

The Coastal Management Program developed over the past two years attempts to provide more guidance and predictablity to the private sector, and emphasizes the strengthening of the administration of existing State laws. These laws can be very effective in regulating coastal development. The program also seeks to reduce unnecessary legal and administrative procedures and identify gaps in existing laws and regulations, and it aims to gain increased control for the State over Federal actions by way of the Federal consistency clause of the Coastal Zone Management Act.

The tentative date for completion of the final environmental impact statement for the Florida Coastal Management Program is April 1981, and it is hoped that the program will receive final approval by the Federal Office of Coastal Zone Management in June 1981.

Because the Florida Legislature has directed the Coastal Management Program to be based on existing laws and regulations, the entire State has been designated as the coastal zone because most of the existing laws are of statewide applicability. Of particular interest regarding multiple-use conflicts is the section of the program dealing with coastal development issues, and the appendices on energy facilities planning and coastal shorefront areas.

DEVELOPMENTS OF REGIONAL IMPACT

The Florida Environmental Land and Management Act of 1972 includes provisions to involve the State in controlling land development. Developments of regional impact (DRI) are subject to a review process. A "development of regional impact" is defined as:

> Any development which, because of its character, magnitude, or location, would have a substantial effect upon the health, safety, or welfare of citizens of more than one county [380.06 (1), F.S.].

Developments presumed to be of regional impact were adopted as Ch. 22f-2 of the Florida Administrative Code and include twelve different types of development. Determination of their classification as a Development of Regional Impact depends primarily on the size of the development. Although the rule creates a presumption, projects not on the list or not meeting threshold criteria may still be determined to be DRI's if sufficient facts regarding the project support the statutory definition.

Briefly, and in broad terms, a developer proposing a project that is determined to be a DRI must file an "application for development approval" with the local government having jursidiction. The appropriate regional planning council must prepare an impact report and submit recommendations to the local government having jurisdiction. The regional planning council must prepare an impact report and submit recommendations to the local government. The report must determine whether the development will have a favorable or unfavorable effect on the environment and natural resources of the region and whether it will unduly burden water, sewer, solid waste, or other needed public facilities, affect housing, or create an additional demand for energy [380.06(8), F.S.].

Clearly the requirements of the DRI process force local governments and regional planning agencies to address multiple-use conflicts relating to a proposed project. DRI's basically apply to large projects that have major environmental as well as social and economic impacts. The process highlights conflicts between the DRI and natural systems and between the DRI and manmade systems. In most instances, the conflicts can be minimized and the DRI process encourages reduction of negative impacts. Occasionally, a project will be rejected in the DRI process because of major conflicts that cannot be resolved. A notable example is the denial of development approval for "The Estuaries," a proposed residential development near Fort Myers that included 26,500 dwelling units on 2,620 ha (6,500 acres) in Lee County. A majority of the proposed site (91.9%) is classified as wetlands, about 1,130 ha (2,800 acres) are predominantly red mangroves, and 730 ha (1,800 acres) are black mangroves (Southwest Florida Regional Planning Council 1976).

AREAS OF CRITICAL STATE CONCERN

The second major provision of the Environmental Land and Water Management Act relates to "Areas of Critical State Concern" (ACSC). The act authorizes the designation of the following three types of areas as ACSC's.

(1) An area containing or having a significant impact upon environmental or natural resources of regional or statewide importance, including, but not limited to, state or federal parks, forests, wildlife refuges, wilderness areas, aquatic preserves, major rivers and estuaries, state environmentally endangered lands, outstanding Florida waters and aquifer recharge areas, the uncontrolled private or public development of which could cause substantial deterioration of such resources.

(2) An area containing, or having significant impact upon, historical or archaeological resources, sites, or statutorily defined historic or archaeological districts. The private or public development of which could cause substantial deterioration or complete loss of such resources, sites, or districts.

(3) An area having a significant impact upon, or being significantly impacted by, an existing or proposed major public facility or other area of major public investment including, but not limited to, highways, ports, airports, energy facilities and water management projects [380.05 (2) (a), (b) and (c), F.S.].

The procedure for designating an ACSC is detailed and lengthy and requires substantial preliminary analysis. As part of designating an ACSC, a set of development priciples applicable to the area must be prepared. Thereafter, any developments taking place within the critical area must be in conformance with the development principles. The main thrust of the ACSC provision of the act is to protect certain important resources of the State from uncontrolled development. To date, the three ACSC's in Florida that have been so designated by the legislature are the Big Cypress, the Green Swamp, and the Florida Keys areas.

INDUSTRIAL PERMITS

Industrial development, including power plant siting, often conflicts with other land and water uses such as housing, recreation, and conservation. These conflicts are especially pronounced in coastal areas where competition for limited resources is intense. Industrial activity is a necessary concomitant of economic development, however, and provisions must be made to accommodate it at suitable locations. The attempts of industry to comply with Florida's environmental and siting laws have been onerous and frequently in a state of disarray, prompting the enactment in 1979 of a streamlined Industrial Siting Act (ch. 288 F.S.). The act, passed to attract new industry, is consistent with the protection of the State's natural resources and environment.

A "Catalogue of Regulatory Procedures" was prepared by the State prior to the Industrial Siting Act in response to the confusion surrounding the State's multiple regulatory programs (Florida Department of Administration 1979). Among the regulations covered in the catalogue are those that deal with environmental issues and industry.

This process of meeting numerous regulations for the issuance of industrial permits is commonly referred to as the "old method," with the "new method" referring to Florida's more recently enacted (1979) Florida Industrial Siting Act (ch. 79-147, Laws of Florida). Neither process supersedes the other. Instead, industries are given an option by the State to select which method of issuing permits they choose to follow. The major difference between these two procedures is the time and cost for obtaining a permit.

Of the 17 permit programs outlined in the catalogue, twelve apply to the procedural methods for setting industrial permits. They include permits for the following: dredge and fill, water pollution sources, solid waste disposal plants, air quality systems, drilling freshwater wells, public and private water supply systems, power plant construction and operation, mined land reclamation, open burning, and for protection of historic sites and properties.

The new process is designed to take seven months from application to completion (approval or denial). Should any delays be requested, the hearing officer in charge of that particular request will determine the validity of the request in deciding whether to grant the delay. The Siting Act also is designed for the applicant to submit all requests for permits to one central office, the Department of Environmental Regulation (DER). This causes the Siting Act to be commonly known as "One-Stop Permitting."

These two elements reflecting the time schedule differ considerably with the "old method." Although the old method denotes certain schedule completion requirements, the overall process often took up to several years for an industry to obtain all the desired permits. This was primarily due to the requirement that applicants submit requests for permits to several different State agencies and wait for each individual permit process to be completed. Sometimes, one permit process had to be completed before another permit could be requested.

Cost is another difference between these two optional processes. Minimal fees are required by the old method. Depending upon the number of permits requested, the entire process would cost \$20 to \$200 or more; each permit costing about \$20. "One-stop Permitting," on the other hand, is more expensive. Fees for this process range from \$2,500 to \$25,000. These fees are to be used to pay for all costs incurred to process the application. An expenditure and balance statement is given to the applicant. These fees are determined during a pre-application process and vary according to the number of permits that are requested by a particular industry.

The siting of power plants with a generating capacity of 50 megawatts (MW) or more is regulated by the Florida Electrical Power Plant Siting Act (ch. 403 F.S.). The act was originally passed in 1973 to deal with the many environmental impacts of electrical generating facilities. Siting licenses are issued by the governor and cabinet and are the only license required under State law for the construction and operation of facilities. The application and approval process requires extensive information on design, location and potential impacts of a proposed power plant. Studies and reports are required of several State agencies and hearings are conducted prior to issuance of the license.

COASTAL CONSTRUCTION CONTROL LINE

The Beach and Shore Preservation Act (ch. 161 F.S.) addresses the problem of construction along Florida's coasts. The act establishes a coastal construction setback line 50 ft landward of the mean high water line. It also provides for a coastal construction control line that supersedes the 50 ft setback line when it is established based on field studies using engineering and environmental criteria for the sandy beaches of each coastal county. Coastal construction control lines are established on an individual county basis to define beach areas where special structural design considerations are required to insure protection of the beach and dune system, upland structures and adjacent property [ch. 161.053(1) F.S.].

After establishment of the coastal line, permits are required for any excavation and construction seaward of the line and vehicles are prohibited on dunes located seaward of the line. Permits may be granted if the State's Department of Natural Resources determines that engineering and topographical data indicate a permit is justified, or if the structure forms a part of a pre-existing line of structures seaward of the line and the pre-existing structures have not suffered unduly from erosion, or if the construction is a pier or pipeline that will not cause erosion (Florida Department of Environmental Regulation 1980).

MAJOR CONFLICTS

Most of the multiple-use conflicts in Southwest Florida are caused by population growth. As the region has grown, major urban and industrial developments have either been proposed or completed, and the growth shows no early sign of abatement. Inevitably, growth led to conflicts between those who would completely preserve existing natural ecosystems and those who would alter land use for development to the maximum extent possible.

The Big Cypress area is an example of how the degradation of one area adversely affects nearby areas. The Sanibel Island conflict traces citizens' action to preserve their natural resources and way of life on this barrier island: Charlotte Harbor illustrates the multi-faceted problems that beset a major residential development.

This section discusses six areas of major conflicts in Southwest Florida over the past quarter century. They are Rookery Bay, Marco Island, Florida Keys, Big Cypress, Sanibel Island, and Charlotte Harbor. These areas were selected to give broad geographical coverage and to illustrate some major examples of conflicts arising from rapid growth and urban development. There are many other major multiple-use conflicts in the region, some of which date back many years, such as port development in Tampa Bay, and oil development in Collier County.

COLLIER COUNTY

Collier County consists of 526,000 ha (1,300,000 acres) of flat sandy lowlands, wetlands, mangroves, and estuaries. Its coastal area (80,900 ha or 200,000 acres) is a fragile ecosystem of mangrove swamps, estuarine meanders, thin barrier beaches, and sandy low-lying shorelands. The county's estuarine resources were virtually undeveloped until the early 1960's when the heavy demand for waterfront development began. It was then that the construction of drainage canals in the interior watershed, dredging of estuaries, and the destruction and filling of mangrove swamps around Marco Island began in earnest (Clark 1974).

The process of urbanization has continued, and today the county's leading industry is residential construction. Collier County currently is attempting to resolve the impacts of its growth and its effects on cultural, economic, and ecological stability. The current major problem is the shortage of fresh water. The drought of 1981 led to serve restrictions on water use and caused saltwater intrusion. Massive fill and land drainage projects helped aggravate the problem.

A conflict between environmental protection of wetlands and residential development is illustrated by the Rookery Bay Wildlife Sanctuary and the Marco Island residential subdivision.

Rookery Bay Wildlife Sanctuary

Because of increasing residential, industrial, and recreational development in the immediate and adjacent areas of Rookery Bay, there has been

considerable interest in preserving this relatively unspoiled area. In an attempt to save at least part of Rookery Bay, county citizens organized the Collier County Conservancy in 1963 and, in cooperation with the Nature Conservancy, purchased 2,000 ha (5,000 acres) of the coastal corridor just south of Naples to create the Rookery Bay Wildlife Sanctuary. Today, the Sanctuary consists of 2,200 ha (5,400 acres) and is privately maintained by the Collier County Conservancy, National Audubon Society, and the Nature Conservancy. In addition, this area has been designated as the Rookery Bay Estuarine Sanctuary by the Office of Coastal Zone Management of the National Oceanic and Atmospheric Administration. This designation earmarks Federal grant money for the acquisition of additional lands which may increase the area to well over 3,600 ha or 9,000 acres (U.S. Department of Commerce 1977).

Studies conducted in 1967 and 1970-73 by the Conservation Foundation supplied environmental baseline data for Rookery Bay and proposed recommendations for continuing management of the sanctuary and the adjacent land and water areas. Baseline data gathered by that study included information on ecosystem components and processes, and water quality.

The three major water regimes of the Rookery Bay sanctuary are surface runoff, underground flow, and estuaries. The water areas associated with land drainage include cypress domes, sloughs, natural swales, marshes, creeks, bays, and manmade drainage canals. Groundwater flow is generally assumed to parallel surface flow moving to the southwest. Estuaries include wetlands, bays, and all bordering areas of marshes, mangroves, and tidal flats.

These water regimes help form habitats for a number of endangered species, including the bald eagle, brown pelican, and the manatee. In addition to endangered species, the Rookery Bay area provides excellent habitat for many valuable species such as oysters, mullet, snook, snapper, redfish, and spotted sea trout (See the Chapter on Commercial Fisheries for Collier County marine landings statistics).

Water quality in the sanctuary is generally good; it is relatively unpolluted except for high concentrations of copper and intermittently high coliform counts caused by sewage discharges. In fact, the bay was closed to shellfishing (oysters, clams, lobster, and shrimp) by the State Water Pollution Board in 1970 because of the potential health hazard of pathogenic organisms in shellfish (Clark 1974). The bay is still closed to shellfishing.

High turbidity in Rookery Bay in recent years has reduced light penetration and photosynthesis of seagrasses and subsequently, their abundance and distribution. The major source of these suspended particles is surface runoff, especially near drainage canals, silt from dredging operations, and spoil placement (Clark 1974).

Another aspect of the sanctuary is the integrity of that system to function as an integrated unit. Water quality and circulation, vegetated estuarine areas, nutrient sources, benthic composition, shellfish beds, and vital habitat areas were assessed in studies to determine the ecological characteristics of the sanctuary. Apparently flushing of the bay waters occurs only during the wet summer months, consequently, in dry months a combination of low freshwater inflow and high industrial and municipal discharges substantially increases the chances of pollution.

Recommendations for managing lands and waters immediately adjacent to the sanctuary were as follows:

Land areas. (1) Excavation for site preparation should be specifically designed to protect the water regimes; (2) residential subdivisions should be designed to retain much of the expected rainfall and release it at a natural rate and acceptable quality; (3) existing artificial drainage facilities should not be expanded either in capacity or length; (4) new drainage systems should be designed to enhance natural drainage; (5) soil from the project should not be removed from the area; (6) impervious surface area should be reduced to a minimum.

Water areas. (1) Improvements should be restricted largely to elevated (above water and vegetation) light-duty recreational and access structures; (2) piers and docks should be built above the 10-year flood return height; (3) vehicular access should be restricted to existing roadways; (4) excavation, grading, and filling without a permit should be prohibited; (5) disturbed lands should be restored to their natural condition; (6) No pollutants should be released into water areas; (7) development within a specific buffer zone surrounding the sanctuary should conform to recommendations for water areas (Clark 1974).

Marco Island

Marco Island is an example of a conflict between a large scale residential development and an area of considerable ecological value. Deltona Corporation began development of Marco Island in 1964. The initial Marco Island development, 4,200 ha (10,327 acres) of uplands and submerged lands on and around Marco Island, was purchased for $7.5 million. The corporation planned to develop homesites in the area, and was unopposed until 1967.

In the late 1960's and early 1970's, environmentalists were alarmed to learn that the dredge and fill methods and creation of finger canals (dead end canals) were detrimental to coastal ecosystems. Deltona finished two of five sections of development before their dredge and fill permits were denied. The denials came after new Federal environmental regulations were passed and after landmark court decisions were made regarding the National Environmental Policy Act.

Two of the dredge and fill permits that were denied involved 13.9 million $meters^3$ (18.2 million yd^3) of fill material. The dredging would destroy 297 ha (735 acres) of seagrass and 850 ha (2,100 acres) of mangrove swamp. Deltona offered the State 1,619 ha (4,000 acres) of land in Caxambas Sanctuary south of Marco Island as mitigation for the dredge and fill permits on Marco Island, but no action has been taken.

Deltona currently is still embroiled in appeals and requests for variances to previous permit denials. Marco Island subdivision consists of 1,600 ha (3,900 acres) of essentially manmade land in the swampy wilderness on and around Marco Island's 6,000 ha (15,000 acres). Marco Island appeared to be environmentally sound in the beginning, but as the environmental consequences were revealed, new restrictive regulations were passed.

FLORIDA KEYS

The Florida Keys extend about 130 miles from the southern tip of the Florida mainland to Key West. There are 97 small low-lying islands in the chain. Key Largo is the largest, over 72 km (45 mi) long, and Key West is the best known. Thirty-five of the islands are connected by U.S. Hwy. 1 from Key Largo to Key West.

Factors that led to multiple-use conflicts in the Keys were a rapid population increase, a limited supply of public services, especially fresh water, intense and divergent land-use demands, historical preservation, a potential for oil and gas exploration and development, and a vulnerable natural environment. The Keys are the home of many unusual animal species and plant communities. The living coral reefs are a unique and valuable feature.

Before completion of the Overseas Railroad (now U.S. Hwy. 1) in 1913, nearly all of the intensive land use in the Keys was concentrated around Key West. The railroad, followed by the Overseas Highway and Navy pipeline, stimulated development throughout the Keys. In 1974, much of the developed land was either single family residential, or under site preparation and construction (Table 1).

The population of Monroe County, which includes the Keys, rose from 47,921 in 1960 to 52,586 in 1970 and to 61,562 in 1980. Population projections for Monroe County are reported in the chapter on population and demographic characteristics. Key West's population in 1960-80, however, showed little increase. Its population was 26,433 in 1950, 33,965 in 1960, 29,312 in 1970, and 30,252 in 1980. These fluctuations were a result of a change in the number of military personnel stationed near Key West. The population is much higher during the tourist season. For example, the tourist and resident population combined was approximately 80,000 in Key West in March 1974 (Florida Department of Administration 1974).

Economic Factors

The major sources of income in the Keys are tourism, commercial and sport fishing, residental construction (including second homes and retirement homes), and the military. Approximately 550,000 out-of-state tourists and 400,000 Floridians living outside Monroe County visited the Keys in 1972. (See the chapter on Recreation and Tourism for additional tourist information.) The gross income generated by tourists in 1972 ranged from 100 million and 150 million dollars (Florida Department of Administration 1974).

Various factors contributed to the economy of the Keys. The largest single element of the Monroe County economy is military. In 1972 the Key West Naval Air Station provided 29% of all employment and 36% of all personal income in Monroe County. Its impact on Key West is even greater (Table 2).

The construction of second homes and retirement homes have contributed substantially to the economy of the Keys. In 1970, about 28% of the households were temporary winter residences. The influx of retired people increased the population and demand for residences. About 13.3% of the County's population was 60 years old or older. The Florida Department of Commerce reports

Table 1. Land area (acres) and land use percentages for the census areas of the Florida Keys in 1974 (Florida Departmen of Administration 1974).

Census Area	Land area	Industrial	Commercial	Tourist accommodation	Residential SF[a]	Residential MF[b]	Residential MH[c]	Military facilities[d]	Under construction/ site preparation
Key West	2,510	0	10	2	44	8	11	21	4
Lower Keys	5,175	7	2	2	31	0	4	19	35
Middle Keys	2,380	2	7	11	29	0	6	0	45
Upper Keys	5,425	1	3	3	47	1	8	1	36

[a] Single family.
[b] Multi family.
[c] Mobile home.
[d] Does not include military housing areas.

that construction industries provide approximately 5% of all the Keys' employment, personal income, and gross sales (Florida Department of Administration 1974).

Table 2. The percentage of services and retail sales attributed to the military in Key West (Florida Department of Administration 1974).

Expenditure	Percentage
City electric system (sale to military bases)	36
Commercial banks (military only)	40
Savings and Loan Association	30
Automobile sales	65
Recreation outlets (military and civil service)	80
Food sales (military and civil service)	60
Clothing sales (military and civil service)	50
Newspaper sales	32

Saltwater commercial fish landings in Monroe County in 1973 were about 16% of the State total. (see chapter on the commercial and sport fisheries for statistics). The sizeable shrimp fishing grounds near Dry Tortugas, 105 km (65 mi) west of Key West, are of particular importance. The quality of sport fishing in the Florida Keys is famous throughout the United States and is a major attraction to tourists.

Public Services

The increasing population in Monroe County has placed severe demands on the freshwater supply, wastewater treatment, and transportation facilities. The delivery of urban services to a string of islands tied together by a series of bridges is more susceptible to interruption than most areas. The Keys, because of their location and low-lying topography, are especially vulnerable to tropical storms and hurricanes.

Supplying fresh water is perhaps the most important public service in the Keys. The high salinity of the aquifer underlying the Keys requires desalination. The new desalination plant at Stock Island, near Key West produces about 3 mgal/d. The primary source of fresh water is the mainland. It is delivered by an 18-inch pipeline that follows U.S. Hwy. 1 from Florida City to Key West. This pipeline was constructed in 1940 and has a capacity of 6.2 mgal/d. The 40-year-old pipeline is currently (1981) being replaced by a 24-inch pipeline that will deliver 13.5 mgal/d. The new pipeline will extend to Marathon in early 1982, and to Key West in 1985 (Personal communication Bruce Adams, SFWMD 21 September 1981).

In the event of a breakdown in the supply of fresh water from Florida City, there is a 3-day supply at the present level of usage stored in 30 mgal/d storage tanks. The water supply is a limiting factor to population growth. In 1979, the Fish and Wildlife Service and the National Wildlife Federation were opposed to the new pipeline and new desalination plant because

the greater supply would encourage even more urban development which would replace or damage the few remaining natural areas of the Keys. As a deterrent, the Florida Keys Aqueduct Authority and the Farmer's Home Administration agreed that any new construction in a 1,620 ha (4,000 acres) area throughout the Keys would not be supplied with fresh water (Horvath 1981).

Waste treatment facilities capable of properly treating and disposing of solids and liquids are vital for the public health of the Keys community. New regional wastewater and solid waste plants were prepared in 1974, when there were about 200 private package plants (small sewage treatment plants) that served the commercial establishments and residential areas. The percentage that used individual septic tanks in unincorporated areas was 95 for the upper Keys, 80 for the middle Keys, and 57 for the lower Keys. In Key West, untreated wastes were discharged into the Gulf Stream through a 4,700 ft outfall pipe. Since 1974, the capacity of the waste handling facilities of the Keys has increased, but accurate information is not available at this time.

Climatic Factors

The physical characteristics of the Florida Keys (small coral islands, 90% below 5-ft elevation, maximum 18 ft) provide little protection from hurricanes or tropical storms. Sixteen major hurricanes have struck the Florida Keys since 1900 (Table 3). The two of exceptional force were the Labor Day Hurricane in 1935 and Hurricane Donna in 1960. Both of these hurricanes had wind gusts of over 180 mph and forced water levels about 13 ft above sea level.

Table 3. Major hurricanes affecting the Florida Keys (Basillie et al. 1980).

Date	Coastal area affected
1906, Oct. 11-20	Florida Keys and Miami
1909, Oct. 6-15	Florida Keys and Miami
1910, Oct. 11-13	Key West to Tampa Bay and Jacksonville
1911, Aug. 9-14	Key West to Pensacola
1919, Sept. 2-14	Florida Keys
1929, Sept. 22-Oct. 4	Florida Keys to Tampa Bay
1935, Aug. 31-Sept. 8	Florida Keys to Cedar Key
1935, Oct. 30-Nov. 8	West Palm Beach to Miami and Key West to Ft. Myers
1941, Oct. 4-12	Miami to Florida Keys and Everglades to Cedar Key
1945, Sept. 12-19	Florida Keys to Miami and northeast coast
1947, Oct. 9-15	Key West to Miami
1948, Sept. 19-25	Key West to Ft. Myers and Ft. Pierce
1948, Oct. 4-8	Florida Keys to Ft. Lauderdale
1950, Sept. 1-7	Key West to Cedar Key
1960, Sept. 9-11	Florida Keys and south gulf coast
1965, Aug. 27-Sept. 12	Florida Keys and Louisiana

Hurricane shelters in the Keys only hold about 3,550 people in the upper Keys (above Seven Mile Bridge) and 4,450 in the lower Keys. These shelters, located at elevations of 12 ft or less, are susceptible to storm waters and hold less than 15% of the Keys year-round resident population. Evacuation to the mainland requires travelling along the Overseas Highway with its two lane width, many bridges, and low elevation. The majority of the population is at Key West, over 130 mi from shelter on the mainland.

The National Hurricane Center cannot predict a storm's track or intensity more than 24 hours in advance of the storm with any assurance of accuracy; therefore, most of the people living in the Keys do not have time to evacuate to the mainland (Balsillie et al. 1980).

Ecological Values

The ecological importance of the Florida Keys is reflected by the large commercial and sport fishing industry of Monroe County. A wide variety of flora and fauna inhabit the unique ecological communities and there are more endangered species here than any other region of the State. The mangrove communities are perhaps the most valuable in the Keys area. The mangroves contribute an abundance of nutrients, function as nursery areas, provide shelter for juvenile fish and other marine organisms, and help absorb potentially destructive waves and currents. Other highly productive biological communities of the Keys are seagrass beds and coral reefs.

To help protect some of the natural and ecologically important communities, three national wildlife refuges (National Key Deer, Great White Heron, and Key West), several State reserves and parks, and an area of critical State concern were formed.

BIG CYPRESS AREA

The Big Cypress Area is a loosely defined, but clearly recognized physiograhic province in southern Florida. It includes most of Collier County, and small parts of Monroe, Broward, Dade and Hendry Counties. The area of the Big Cypress watershed in Southwest Florida is about 634,000 ha (2,450 mi^2 or 1,568,000 acres). It has a circular configuration and measures approximately 96 km (60 mi) east to west and 80 km (50 mi) north to south. Several features of the area are the Big Cypress Swamp, Big Cypress National Preserve, Everglades National Park, the Ten Thousand Islands, the Naples urban area, the Big Cypress Federal Seminole Reservation, the Florida Miccosukee Indian Reservation, and the Immokalee Community. Alligator Alley (Everglades Parkway) and Tamiami Trail (US-41) traverse the area (Florida Department of Administration 1973).

Legislative Action

The Florida Legislature passed the Big Cypress Conservation Act of 1973 so that the Big Cypress watershed could be designated as an area of critical State concern as authorized by the Land and Water Management Act of 1972. The 1973 legislation also authorized a $40 million State contribution for the establishment of the Federal Big Cypress National Fresh Water Reserve (Carter

1974). Acquisition for and management of lands within the National Reserve are the responsibility of the National Park Service.

Water Regimes

The Big Cypress Area has unique natural features. Its watershed is a major hydrologic unit characterized by a low-lying, poorly drained, sand and limestone flatland. The elevation ranges from mean sea level to 7.6 to 9.0 m (25 to 30 ft), but most of the area is below 4.6 m (15 ft) in elevation. Slopes range from 0.2 to 0.5 ft per mile north to south and 0.3 ft per mile east to west, and are covered with extensive areas of standing and slowly moving water during the wet season. Much of the area consists of marshes, strands, and sloughs (Florida Department of Administration 1973).

The Big Cypress Area is one of the Everglades National Park's primary water sources. Any further urban development of the Big Cypress Area would reduce the vital southward flow to the park and potentially pollute the water with pesticides, sewage, and other wastes. During the rainy season the area soaks up water like a giant sponge. The runoff flows into the park, but much of the rain recharges the shallow aquifer on which Collier County depends for its freshwater supply. Nutrient levels in nearby estuaries are partly dependent upon the runoff from the Big Cypress Area and unusually severe interruptions or changes in flow could damage fish or shellfish nursery and fishing grounds (Blake 1980).

The shallow aquifer of Southwest Florida is the primary source of potable groundwater for the Big Cypress Area and urban and agricultural use in adjacent areas. Sometimes saltwater intrusion occurs inland of coastal areas during dry years, so it is important to maintain the Big Cypress Area's capacity for shallow aquifer recharge.

The water resources of the Big Cypress Area also provide other natural habitats. The sloughs, hammocks, and cypress-domes are inhabited by nearly all wildlife species native to semitropical Florida, as well as nine threatened or endangered species. Estuaries of the Big Cypress Area and the adjacent Everglades National Park are important as natural resources because they comprise the single most important commercial and sport fishing nursery grounds in the State of Florida and they provide recreation, particularly boating and fishing, for millions of residents and tourists (Florida Department of Administration 1973).

Urban Development and Drainage

The conversion of agricultural or undeveloped land to residental, commercial, or industrial urban uses replaces valuable natural habitats and usually alters the quantity, quality, and flow of water in the area. Drainage canals lower ground and surface water levels because they are designed to drain a site for urban or industrial construction. Canals form artificial water tables that tend to reduce the natural storage capacity of the aquifers. The seriousness of the effects of canal drainage is dependent upon the location, size, and design of the canal. In some areas canal drainage has increased the incidence of forest fires.

Canals in the Big Cypress Area drain storm waters so rapidly that the normal salinity of the estuaries is altered. Canals that are directly connected to estuaries sometimes discharge excessively large volumes of storm water, sewage, and urban runoff during the wet season. Moreover, during either the wet or dry season, disrupted water flows may change estuarine salinities, alter the availability of nutrients, and change water levels that are essential for more productive estuarine fisheries.

Canals also affect the level and the quality of the ground water. The water table may be reduced because of excessive rapid runoff and loss of ground water due to seepage into canals. Saltwater intrusion is likely where water table levels have been drastically lowered by drainage canals and where saltwater barriers have not been provided in the canals. Contaminated urban runoff sometimes seeps into the ground water.

Urban development of wetlands and other low areas usually requires the filling of wetlands and raising the natural grade of the land. By displacement, dredge spoil may completely alter the surface area and water flow patterns of a particular area. For example, runoff from any new construction may cause excessive soil erosion and turbidity downstream during the construction phase.

Other adverse effects generally associated with urban displacement of wetlands are the reduction of aquifer recharge, increased urban runoff because of the abundance of impermeable surfaces, increased saltwater intrusion due to low ground water, and contamination of the ground water caused by improperly encased, valved, or sealed deep water wells.

Residential Development

Most new environmental stresses in the Big Cypress area may be traced to the rapid population increase of the city of Naples as a winter resort in the 1960's, and population increases in Collier and Lee Counties. The Gulf American Land Corporation and its successor, GAC Properties, purchased about 150,000 ha (371,000 acres or 580^2 mi) for suburban development in Collier County, one of the largest land sale ventures of its kind.

Gulf American's largest land sale promotion in Collier County (and western Big Cypress Swamp) was "Golden Gate Estates." This subdivision covers 45,731 ha (113,000 acres) and is located some 24 km (15 mi) from Naples. Golden Gate Estates was marketed as "semi-improved" land because the area contained a grid of flood control canals and roads. The sales practices of GAC Properties led to court suits and were cited in congressional hearings of the mid-1960's that led to the passage of the Interstate Land Sales Full Disclosure Act of 1968.

Damage to the land and water resources caused by the Golden Gate Estates subdivision was extensive. This subdivision stretches across the Big Cypress Swamp about 40 km (25 mi) north to south and nearly 21 km (13 mi) east to west. Approximately 172 km (107 mi) of canals and 1,200 km (807 mi) of roads were constructed to serve residential development. The grid of roads and canals was planned and built before proper consideration was given to its effects on water resources and wildlife.

The network of canals dug by GAC in the Big Cypress Area has impaired freshwater resources, and contributed to forest fire potentials. The canal system drains 101,000 ha (390 mi^2), an area over twice as large as the subdivision alone. Apparently, the water table in the Big Cypress Area has fallen between 0.6 and 4.6 m (between 2 and 15 ft) as a result of the Golden Gate Estates development. In 1970-72, the volume of fresh water lost through GAC Properties' Fahka Union Canal was equivalent to the total water needs of about 2 million people. Because of the "artificial drought" conditions caused by the drainage canals, the Big Cypress Area is more susceptible to destructive fires. Major fires occurred in 1971, 1973, and in the spring of 1981.

In addition to stresses on the natural resources by Golden Gate Estates, heavy burdens have fallen on local governments. Collier County has assumed maintenance responsibility for a large part of the road and canal system of this subdivision. The roads have deteriorated rapidly, but receive so little use that to maintain them is pointless, especially at an estimated cost of over $314,000 per year. The canals have become choked with water hyacinths and other exotic water weeds (Carter 1974).

BEACHES AND BARRIER ISLANDS

The barrier islands that are the most important ecologically and a boon to tourists are Caladesi Island, Treasure Island, Captiva Island, Sanibel Island, and the Florida Keys.

In their natural state, barrier islands are a coastline's first line of defense against hurricanes and tropical storms. The islands absorb enormous wave, wind, and tidal forces and their beaches and dunes may shift substantially as a result of these forces. Some grow larger through deposition, and some recede through wind and wave erosion. Although barrier islands generally are physically unstable for suburban development, they tend to be ecologically stable despite their dynamic nature (LaRoe 1980). When left in its natural state, the coastal environment generally is highly resilient.

Beach erosion is a natural and continuing process that affects all of the barrier islands along the gulf coast. Erosion often results in economic loss because of severe physical damage to residential and commercial structures, roads, beaches, and other features. The extent of erosion in Southwest Florida is summarized in Table 4.

When residential and commercial developments are imposed on a barrier island, the environment tends to destabilize. Manmade structures, especially engineering attempts to stabilize beaches, often disrupt the natural process with disastrous results. The action usually results in a new stress that upsets the balance of natural processes. When beach erosion develops, artificial attempts sometimes are made by adding sand to the depleted beaches. The cost of beach renourishment, which is by no means a permanent solution, is near $3 million/mi in Florida (Greene 1981). Despite the erosion and instability of barrier island beaches, residential, commercial, and recreational development is continuing at a fast pace there.

Table 4. Beach erosion (in miles) in Southwest Florida (Florida Department of Environmental Regulation 1980).

County	Beach length	Critical erosion[a]	Non-critical erosion[b]
Pinellas	35.4	4.0	16.0
Manatee	14.0	12.4	0
Sarasota	35.0	5.0	6.0
Charlotte	14.0	4.4	0
Lee	44.0	6.7	2.0
Collier	35.4	13.0	22.4
Total	177.8	45.5 (26%)	46.4 (27%)

[a]Critical erosion applies to urban-related developed shoreline areas where buildings and public facilities may be threatened. It does not relate to the rate of erosion.

[b]Non-erodable beaches, 91.9 miles, 47% of the total.

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Sanibel Island

Sanibel Island, located near the mouth of the Caloosahatchee River off the coast of Lee County, generally is representative of the conflicts that surround the barrier islands in Southwest Florida. In Sanibel Island, residents have attempted to preserve the natural beauty and resources that are necessary for the island's continued prosperity.

The causeway built in 1963 linked the island to the mainland and stimulated a steady increase in the population. In 1963, the population of the island was less than 1,000, but by 1980 it increased to 3,868 (U.S. Department of Commerce 1981). To protect their island from indiscriminant developments such as were seen on Marco Island, Miami Beach, and St. Petersburg beaches, county residents began a drive for home rule in 1974.

Sanibel Island residents did not want the fate of their island to be in the hands of county commissioners who at the time were prodevelopment. There was strong opposition to the incorporation charter by county developers and the Chamber of Commerce, and in 1974 each side of the conflict took their cases to the State Legislature. The decision by the legislature, after months of political maneuvering by each side, was to grant Sanibel Island a charter for incorporation, but the conflict was far from over.

After approval of the charter, county interests for further suburban development filed two court suits in an attempt to block a referendum vote by the island's residents that would ratify the charter. Both of these suits were dismissed and on 5 November 1974 the City of Sanibel was incorporated. On 16 December 1974 the first city council took office and governmental ties with the county were severed.

The mode of development of Sanibel Island is uncertain. Although the newly established government has taken steps to protect the island's natural resources, the legacy of urban development remains. Many of the people are seasonal residents. In 1970, the population was only 1,000, yet there were 1,569 condominium units. Moreover, between the date of the referendum and the date the new city commissioners took office, Lee County Officials granted 74 building permits valued at $9,618,400 (Lotz 1975).

CHARLOTTE HARBOR

Areas of Critical State Concern

In April 1975, the Environmental Confederation of Southwest Florida nominated several coastal regions of Sarasota, Charlotte, and Lee Counties as Areas of Critical State Concern. The Florida Environmental Land and Water Management Act of 1972 (Ch. 380, Florida Statutes) established the term "Area of Critical State Concern (ACSC)", as a protective designation for areas that meet certain criteria outlined earlier in this report. The Florida legislature is the final designating body for an ACSC (Stroud 1979). To date, only three areas have been so designated, but several others have been nominated.

After an extensive study centered in the Charlotte Harbor area by the former Division of State Planning, it was concluded that this area contained resources and public investments of regional and statewide importance. Two events led the Division of State Planning not to recommend this area as an ACSC. First, the First District Court of Appeals ruled that the critical areas section of Ch. 380 was an unconstitutional delegation of authority. Also, the Division recommended a Resource Management and Planning Program instead of an ACSC designation. Favorable experience from a program for the Apalachicola River Basin, with a combined multi-agency management and planning program, together with the uncertain legal future of critical areas, induced the Divison of State Planning to recommend a similar program for the Charlotte Harbor Area (Florida Department of Administration 1978b).

The Charlotte Harbor Resource Management and Planning program has the following objectives:

(1) Assist the State's interest in protecting the resources of the Charlotte Harbor area.

(2) Unify the multitude of State, regional, and local programs, plans, and policies for this area to avoid costly duplication of effort and to eliminate local confusion of the State goals in the area.

(3) Provide a stimulus for the implementation of the State, regional, and local plans, programs, and policies.

(4) Provide the local governments with an opportunity to strengthen and coordinate their land-use management capabilities without the statutory time constraints of a critical area designation.

Harbor Characteristics and Growth

In general, these objectives are designed to address the current and anticipated problems and conflicts that plague the Charlotte Harbor area. The governing board of the Charlotte Resource Management and Planning Program will decide in the fall of 1981 if the program has been effective. The board may recommend the Charlotte Harbor Area for ACSC designation if the program has proved ineffective (Personal communication R. McKee, Bureau of Land and Water Management, Florida Department of Community Affairs, Tallahassee, FL; Fall 1980).

Bordered by barrier islands in the Gulf of Mexico and fed by meandering rivers to the east, the bays and estuaries of the Charlotte Harbor area nourish and shelter some of the richest commercial and sport fisheries in Florida. The beaches of Gasparilla, Sanibel, Captiva, and Cayo Costa are well known nationally. These unpolluted beaches and bays draw tourists and new residents from all over the United States. In fact, Sarasota and Charlotte Counties are among the fastest growing counties in the Nation, and Lee County is the fastest growing county.

Many factors are responsible for this phenomenal growth. Perhaps the most conspicuous was the nationwide land sales by several large land development companies in the 1950's. These companies bought large tracts of land, subdivided them, and offered the lots for sale in aggressive promotional campaigns. These enormous sales have, in effect, saddled Sarasota, Charlotte, and Lee Counties with a potential two million additional residents. Among the largest land sales developments were Port Charlotte, North Port Charlotte, Rotunda, Lehigh Acres, Punta Gorda Isles, and Cape Coral. Hundreds of thousands of lots in these developments were bought by out-of-state residents, mostly as investments or as future retirement homesites.

A brief discussion of one of these subdivisions, Port Charlotte, will provide some insight into the effects of population growth and urban development.

Port Charlotte

Port Charlotte, a 479 km^2 (185 mi^2) subdivison on Florida's gulf coast, is the General Development Corporation's (GDC) earliest and largest project. This area lies at the end of Charlotte Harbor, a few miles from the Gulf of Mexico, at a point where the Peace and Myakka Rivers enter the harbor. The site stretches across the largely rural counties of Charlotte, Sarasota, and DeSoto and contain approximately 200,000 platted lots. Today about 85% of these lots have been sold, but only 5% (35,000 persons) has established residence there. This subdivision alone has the capacity for increasing the area's population by some 700,000 residents (Allen et al. 1977).

Three major conflicts arose since sales began in 1956. The first conflict concerned a small parcel of land known as Grassy Point at the south end of Port Charlotte's development. GDC began dredging and filling this 61 ha (150 acre) mangrove area in 1970. Because they did not have a permit, GDC was issued a cease and desist order by the Corps of Engineers in January 1971. Final resolution of this conflict came in November 1971 when the Florida Department of Air and Water Pollution Control ordered the developers to restore this area to its original condition.

A second area of conflict over which GDC encountered legal problems was South Gulf Cove, a mostly swampy and low-lying area with mangroves at the water's edge, which was platted and almost completely sold on the basis of a design that called for extensive finger canals. The developers, realizing that they would have difficulty in obtaining permission to dredge an access canal to this site, modified the original plans to incorporate a navigation lock and interceptor lagoon. This mitigation won GDC approval of the original plan.

The Muddy Cove area, platted as the Myakka Estates, had development constraints similar to those of South Gulf Cove and GDC again offered construction modifications to gain development approval. This time there were new regulations for development. The Developments of Regional Impact provision of the Florida Statutes mandated closer review of projects that have regional implications. Since GDC could not show any real need for the housing to be created by this subdivision, plans for it were not approved (Allen et al. 1977).

Water Supply and Demand

Rapid population growth stimulates demand for new services which, in turn, simulate the economy, but the growth is an added strain on limited local budgets, and a stress on limited water resources, waste treatment facilities, and transportation systems.

Many homesites in the Charlotte Bay area were developed by converting tidal marshes and inland swamps. As this type of development took place, few people were concerned about the future of three million potential residents along the shores of Charlotte Harbor. In the last few years, however, there has been an increased awareness of the environmental consequences of the residential construction boom in the past three decades. Now the major issue is the supply and demand of potable water.

The quantity of water used in Florida is regulated by permits from the State's water management districts. The Southwest Florida study area is divided between two districts. The Southwest Florida Water Management District consists of the following counties: Desoto, Hillsborough, Manatee, Pinellas, Sarasota and western part of Charlotte. The South Florida Water Management District includes Collier, Lee, and Monroe Counties, and the eastern part of Charlotte County. The two districts have different methods of quantifying water use data (Tables 5 and 6).

Table 5. Water use (expressed as Mgal/d) permits issued for Southwest Florida in 1980.

County	Public supply	Agriculture	Industrial	Misc.	Total
Charlotte[a]	9.7	26.0	0	1.3	37.0
Desoto	6.2	128.7	7.9	5.4	148.2
Hillsborough	214.2	125.1	129.6	3.4	472.3
Manatee	24.5	161.1	13.4	0.1	199.1
Pinellas	60.1	8.6	0.1	0.2	69.0
Sarasota	20.7	51.6	0	0.7	73.0

[a]Charlotte County is split between two water management districts.

Table 6. Average daily water supply allocation (in Mgal/d) and daily irrigation requirements for South Florida (Charlotte, Collier, Lee, Monroe Counties) in 1980.

County	Public supply average daily allocation	Agriculture-irrigation, maximum month on a daily basis
Charlotte[a]	0	197.8
Collier	34.0	1,401.8
Lee	32.1	370.4
Monroe	1.4	0.3

[a]Charlotte County is split between two water management districts.

Except for the two urban counties (Hillsborough and Pinellas) and Monroe County, more water is used for agriculture than for the public water supply. Monroe County is made up of the Everglades National Park and the Florida Keys. The counties of Southwest Florida represent a continuum of water from almost totally urbanized Pinellas county to the rural Desoto county. The Charlotte Harbor area is becoming rapidly urbanized.

Existing platted subdivisions have the potential for two million additional people in the Charlotte Harbor area. The water supply requirements to accommodate such a population would be eight times greater than current consumption, and would have to be met through new capacity storage.

The Charlotte Harbor area does not have a reliable water supply. Fresh water comes primarily from seasonally intermittent streams, and from aquifers with low water quality. The Hawthorne aquifer is increasingly subject to saltwater intrusion because of a lowered water table caused by increased domestic and industrial use of ground water. The water supply in the aquifer has been reduced partly because most urban development greatly accelerates runoff.

Water regimes also have been changed by accelerated runoff. The estuaries and wetlands now receive larger volumes of fresh water after each rainfall and less fresh water during dry periods. The extremes of high and low input widen the range of salinity conditions in the estuaries, which may upset the life cycle of some animals and plants. The increased rate of runoff also reduces the time water is subject to the natural filtration. Nutrients are flushed directly into creeks, streams, and bays where excesses may cause undesirable algal growth.

A spill of phospate slime in 1967 killed an estimated 90% of the fish stocks in the Peace River, but by 1971 the fish population almost completely recovered. With supplemental fish stocking, the fish population made significant gains within 15 months (Bell 1977).

The demand for water in Southwest Florida is not limited to domestic use. The phosphate mining district of Polk, Hardee, and DeSoto Counties in the upper reaches of the Peace River and its tributaries is a case in point. Large volumes of fresh water used in phosphate mining and processing are discharged into slime ponds (which hold millions of gallons of phosphatic clays) near the Peace and the Myakka Rivers. If phosphate mining and processing increases along these rivers, threats to public water supplies and to estuaries will become greater. For example, in In 1971 an earthen dam surrounding a 250-acre phosphate slime pond ruptured and released an estimated one billion gallons of phosphatic clay slime into Widden Creek, a tributary of the Peace River. The slime entered the Peace River and continued downstream through Polk, Hardee, and DeSoto Counties and into Charlotte Harbor. The spill caused a severe ecological disaster that affected not only aquatic communities and water quality, but associated terrestrial life as well. An estimated 95% of the freshwater fish stocks on Widden Creek and Peace River were killed.

Another potential threat to the water supply of Southwest Florida is from the leachate of gypsum piles or stacks, a byproduct of the phosphate industry's chemical processing plant. Rain collects on top of these gypsum stacks

and seeps through the pile to the ground below. The gypsum contains various acids, hazardous chemical wastes, and radioactive residues. The U.S. Geological Survey (USGS), working with the Florida Department of Environmental Regulation and the phosphate industry is now studying the effects of water seepage from gypsum stacks on the ground water. The findings of this study will be reported in late 1981 (Personal communication with Cynthia Cosper and Geoffrey Watts, Florida Department of Environmental Regulation, Tallahassee, FL; Fall 1980).

Electrical Power Plants

Coastal sites often are chosen for power plant sites because marshland prices are low and water for cooling is abundant. Southwest Florida has only one power plant which is near Ft. Myers. As Southwest Florida grows the demand for electricity may require additional power plants. The potential for environmental disturbance by power plants is usually greater than other large-scale industrial developments. Construction of the plant may destroy some important estuarine habitats and discharge thermal pollutants and sediments in coastal waters. Thermal pollution can have adverse effects on aquatic life and damage grass beds.

Power plants are critical to economic growth for the whole of southern Florida. Restriction and regulation of power plant location and/or operation (e.g. closed-cycle cooling) for environmental purposes will increase the price of energy from this source.

SUMMARY AND CONCLUSIONS

The coastal environmental crisis in Southwest Florida is an example of an entire coastal ecosystem that has been seriously altered by the industrial, residential, and commercial developments and too little regard for the integrity of the natural environment. The design of these developments has been imposed by an economic system that largely invests in urban uses that promise high profits rather than protection of the natural environment.

The development of institutional procedures for responding to the failures of the private enterprise system to consider environmental planning is indeed a difficult task. Enforcing regulations to control or reduce ecological damage may appear to be prohibitively expensive, but protection of the natural environment in the near future is imperative.

The trade-offs between the economy and the environment will depend on society's evaluation of the need for maintaining viable coastal ecosystems as opposed to further residential and industrial development. Local government zoning commissions may become instrumental in developing balances among needs.

The topic of multiple-use conflicts is broad and does not lend itself to clearly defined sets of data. Several issues addressed in this paper were based upon a limited amount of information drawn from a variety of sources. Most needed is accurate land use data that reflect the type and intensity of development, value of land, and value of improvements. Assessments of the

impacts of development on the environment would be more accurate if there were better information on industrial pollution and costs of investments in pollution control.

The subjects selected for discussion in this chapter were chosen because they were areas of special concern. The Charlotte Harbor, Big Cypress Swamp, and Florida Keys have been studied as Areas of Critical State Concern. The Areas of Critical State Concern study process has generated more data about these areas than are available for other areas of Southwest Florida.

Rookery Bay, Marco Island, and Sanibel Island were areas where public controversy generated the need for data. The level of data in some of these areas is exceptional, while others are found wanting.

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ENVIRONMENTAL ISSUES AND REGULATIONS

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INTRODUCTION

Not too many years ago America was a land of boundless energy, fresh air, and clean water. The steadily increasing population, technological development, and consumer demands have changed all that. The greatest issues have been the decline in the quality of our air and water, and the loss of fish and wildlife habitats, problems of universal scope and ones that are causing concern in Southwest Florida. Our major defense is environmental concern, which if properly focused and implemented, will stimulate action directed toward environmental protection and wiser use of natural resources.

Environmental issues must be considered in terms of their economic ramification. Environmental decisions have wide-ranging impacts, and the wrong decisions can result in millions of dollars lost to State and local economies. In 1980 tourists contributed $17 billion dollars to the Florida economy. The large number of tourists and retirees in Florida is evidence of an abundance of clean air and water. It is also a reminder that any substantial increase in pollution must be checked if the tourist/retiree economy is to be maintained and enhanced.

Man's existence demands that he employ the resources of the ecosystem and be allowed in some form to alter its natural state. This alteration involves some negative environmental consequences. A balance between resource use and protection requires information on the value of environmental resources, monies generated by their use, and the ultimate cost to the environment resulting from their use.

Air pollution usually comes from industrial areas in or near cities -- prime sources that often can be identified and sometimes resolved. More insidious is air pollution from the exhausts of automobiles, which sometimes is more dangerous and difficult to control. Air pollution can be a public health problem, especially to the elderly, the very young, and those with respiratory ailments. It reduces the outdoor enjoyment, sometimes forms unsightly and dismal smog, corrodes metal surfaces on buildings, and at its worst it causes respiratory problems. In some areas of the United States, particularly in the Northeast, sulfur particulates discharged from fossil-fueled steam plants enter the upper atmosphere and cause acid rain, a relatively new but apparently devastating phenomenon that acidifies lakes and ponds, and can alter the growth of vegetation and aquatic life (Brezonik et al. 1980).

Major water pollutants and contaminants encountered in or near populated areas frequently include industrial and municipal wastes including heavy metals, fecal coliform bacteria, and synthetic organics. In rural areas, biocides and fertilizers are major contaminants (when in excess). Turbidity (dissolved solids) and sedimentation caused by sheet and gully erosion in agricultural and logging areas may also contribute to water pollution. Antipollution measures in the United States are only partially successful and the cost of abatement in some areas is staggering, sometimes prohibitive. Because of the high cost of pollution abatement, natural habitats and populations of fish and wildlife too often are ignored, partly because their benefits cannot easily be converted to dollars and cents. The cost of abatement or mitigation usually is passed on to the consumer by increasing the cost of electricity, in fossil-fueled steam plants as an example, but fish and wildlife largely receive only secondary consideration and compensation for losses is rare.

Costs for preventative abatement are usually much lower than for corrective measures, a consideration that should be given in any pollution abatement program. To eliminate or reduce current air and water problems at their source and to suppress new or expanding pollution potentials in Southwest Florida, some rather positive, more far-reaching attempts will have to be made to control or limit pollution and to help satisfy environmental concerns. Pollution in Southwest Florida is not as serious as it is in many parts of the United States, and potentials for pollution abatement are relatively good.

This report focuses on the real and potential effects of air and water pollution on the natural and manmade environment in Southwest Florida, man's encroachment on these natural resources, and regulations designed for their resolution. It concerns lakes, creeks, rivers, lagoons, channels, bays, estuaries, barrier island passes, and the air above. It relates to the socioeconomic structure and growth in the urban, suburban, and rural communities. It lists water quality standards and current levels of compliance, emphasizes clean air and water for residents and tourists alike, and describes some of the chemical properties and pollutants of surface and ground waters in Southwest Florida. It also describes environmental problems concerning man's encroachment on the natural environment and environmental regulations and controls.

Southwest Florida consists of Pasco, Pinellas, Hillsborough, Manatee, Sarasota, Charlotte, Lee, DeSoto, Collier, and Monroe Counties. It is characterized by warm weather, high annual rainfall, and high humidity. Average January and July temperatures (°F) are in the mid-60° and the low 80° range, respectively. The mean maximum and minimums in January are in the mid-70° and mid-50° range, and those in July are in the 90° and 70° range, respectively.

Florida has high rainfall from May through September (65% of the total in 5 months), and low rainfall from October through April (7 months). The relatively low winter rainfall is caused by cyclonic storms that characterize the eastern United States. Summer rainfall is attributed to convection storms that are most common in the afternoon and early evenings. In summer, rainfall is usually intense, but of short duration (1 to 2 hours) and highly localized. Large tropical storms usually produce heavy rainfall over wide areas. Annual rainfall averages between 50 and 55 inches.

Southwest Florida is divided into the western highlands and the coastal lowlands of the coastal plains. Typically, the area is comprised of low, nearly level plains and gently undulating to rolling hills with intermittent ponds, swamps, marshes, lakes, and streams. Elevations range from sea level to about 300 ft (91.4 m) above sea level in the highlands.

Most soils are moderately drained and not often subject to flooding. Detailed soil maps have been completed for Hillsborough, Pinellas, Manatee, and Sarasota Counties. More detailed soil descriptions and maps are available from the Soil Conservation Service Soil Surveys. The major soil types are flatwood lowlands, southern limestone, and swamp marsh bottomlands.

AIR QUALITY

A summary of Federal and State standards for the major pollutants regulated within Florida are given in Table 1.

AMBIENT AIR QUALITY

Except for the Tampa Bay area, Southwest Florida generally has good air quality. The major nonattainment counties in Florida are Hillsborough and Pinellas Counties, each of which has two nonattainment areas within their boundaries. Pinellas County is a nonattainment area for ozone throughout the entire county and a nonattainment area for sulfur dioxide (SO_2) in the northernmost portions. More specific problems are identified in the Tarpon Springs area. Hillsborough County is a nonattainment area for ozone throughout the entire county, and a particulate nonattainment area in downtown Tampa. The following is a brief discussion of major pollutants and their respective ambient concentrations across Southwest Florida.

CURRENT STATUS OF AIR POLLUTION

Major pollutants measured and reported here are TSP, sulfur dioxide, and nitrogen oxides.

Total Suspended Particulate Matter (TSP)

TSP has been a long-term problem in the greater Tampa Bay area. A description of the status of TSP in Southwest Florida is given in the following subsections. The State standard for TSP is 60 ug/m^3 and the Federal standard is 75 ug/m^3.

Hillsborough and Pinellas Counties. The State and Federal standards for TSP were exceeded in the downtown Tampa area. Concentrations in Tarpon Springs also approached the Federal primary standard in 1979-80.

Table 1. National and Florida ambient air quality standards[a]; ug/m^3 = microgram per cubic meter (Florida State Department of Environmental Regulation, Bureau of Air Quality Management 1980).

Pollutant	Time frame	Primary standards	Secondary standards[b]	Florida standards
Particulate matter	annual (geometric mean[c])	75 ug/m^3 [c]	60 ug/m^3	60 ug/m^3
	24-hour	260 ug/m^3	150 ug/m^3	150 ug/m^3
Sulfur oxides	annual (arithmetic mean[d])	80 ug/m^3 (0.03 ppm)[e]	150 ug/m^3 (.02 ppm)	150 ug/m^3 (0.02 ppm)
	24-hour	365 ug/m^3 (0.14 ppm)	260 ug/m^3 (0.1 ppm)	260 ug/m^3 (0.1 ppm)
	3-hour[b]		1300 ug/m^3	1300 ug/m^3 (0.5 ppm)
Carbon monoxide	8-hour[b]	10 ug/m^3 (9 ppm)	(same as primary)	(same as primary)
	1-hour[b]	100 ug/m^3 (35 ppm)	(same as primary	(same as primary)
Nitrogen dixoide[f]	annual (arithmetic mean)	100 ug/m^3 (0.05 ppm)	(same as primary)	(same as primary)
Photochemical oxidants[g]	1-hour[b]	235 ug/m^3	(same as primary	160 ug/m^3 (0.08 ppm)
Hydrocarbons[h] (nonmethane)	3-hour (6 to 9 a.m.)	160 ug/m^3 (0.24 ppm)	(same as primary)	(same as primary)

[a]The air quality standards and a description of the Federal Reference Methods (FRM) were published on April 30, 1971, in 42 CFR 410, recodified to 40 CFR 50 on November 25, 1972. The new FRM for nitrogen dioxide was published on December 1, 1976, as 40 CFR 50.

[b]Not to be exceeded more than once a year.

[c]Geometric mean is a measure of central tendency. It is the nth root of the product of n individual data values recorded during the given period.

[d]Arithmetic mean is the most common measure of the central tendency. It is the sum of the data collected during the given period divided by the number of observations in the same period.

[e]Parts per million.

[f]Chemiluminescence has been established as the FRM and the sodium arsenite and trienthanolamine guiacol sulfite (TGS) methods have been identified as equivalent methods.

[g]The FRM measures O_3 (ozone).

[h]The hydrocarbon HC standard is a guide to devising State implementation plans to achieve the oxidant standard. The HC standard does not have to be met if the oxidant standard is met.

Lee County-Fort Myers. The average TSP for the Fort Myers area was about 40 ug/m^3 in 1979.

Manatee County. In the early 1970's Manatee County had relatively high TSP readings at several locations. They ranged from 48 to 64 ug/m^3, but by 1979 they dropped to 30 to 45 ug/m^3. The only exception to the decline was reported from station 102540012 which was not representative (Florida State Department of Environmental Regulation 1980a).

Sarasota County. TSP data have been collected at five major particulate monitoring stations or sites. In 1973-79, average annual TSP's at three stations declined from about 50 to 40 ug/m^3, and the TSP at another station fell from 73 to 45 ug/m^3. TSP's at two sites increased from 30 to 46 ug/m^3. All TSP's were well below the State and Federal primary TSP standards.

Sulfur Dioxide

Pinellas County. Pinellas County has been declared as a sulfur dioxide (SO_2) nonattainment area because of violations of State and Federal air quality standards. Sulfur dioxide concentrations in the other counties of southwest Florida have been relatively low and do not constitute a problem.

Hillsborough County-Tampa. Nine air monitoring stations were located in Hillsborough County-Tampa Bay in 1972-79. Most stations reported a decline in SO_2. The highest, in Tampa, fell from 44.2 to 10 ug/m^3 in 1974-79 and SO_2 at more rural stations fell from 26 to 10 ug/m^3 in 1973-77.

Pinellas County-St. Petersburg. SO_2 concentrations at each of three stations in 1978-79 was about 2 to 3 ug/m^3, whereas SO_2 fell from 49 to 18 ug/m^3 and from 59 to 3 ug/m^3 at two stations near Tarpon Springs.

Lee, Manatee and Sarasota Counties. All stations maintained low concentrations (3-5 ug/m^3) in 1973-79.

Nitrogen Dioxide

All counties tested for nitrogen dioxide (NO_2) were well below the State primary and secondary air quality standards. For example, average annual nitrogen dioxide concentrations at Tampa in 1974-79 ranged between 25 and 30 ug/m^3.

ECONOMIC LOSS CAUSED BY AIR POLLUTION

The approach used in estimating the economic costs of secondary impacts from air pollution are wide and varying. The secondary costs (dollar loss) of air pollution in the United States as determined by Waddell (1974) were $4.3 billion for health, $1.1 billion for material damage, and $5.5 for property damage. Another estimate of secondary costs is about $16.1 billion per year, which averages about $74.00 per person per year (Seskin and Lane 1977).

The concern of Floridians about environmental policy were revealed in a report on "Florida Citizens' Policy and Trade Off Attitudes: Environmental Development and Energy" prepared by the Department of Economics and Government at Florida State University. It stated that:

> More than half the Floridians were willing to pay more in taxes and utility bills to help clean up pollution .... Floridians expressed higher interest in environmental issues today than they did five years ago although the intensity of this interest has declined due to a rise in inflation and energy issues .... most Floridians prefer to forego economic growth if it threatened environmental quality.

Most of those queried said that they would pay 0.3% to 0.5% of their annual family income to fight pollution.

Another Florida-specific study examined the relationship between changes in property value as a function of air pollution (Milliman and Sipe 1979). The theory suggests that the perceived changes in air pollution would lead to capitalizing that perception into the value of the land, and that high property values are associated with high quality air. The general conclusions by Milliman and Sipe (1979) after examining the Tampa Bay area and using cross sectional analysis were as follows:

> Florida has good air quality compared to other regions in the United States. With low levels of pollutants observed, we should not expect to see significant damages and the detection of damages is more difficult. In general, benefits of air quality improvements that can be measured with existing secondary data are very small or nonexistent. We do not say that benefits are low. We do say that we have not been able to measure them given existing data and a low-budget approach. Moreover, benefits that can be measured appear to be elusive in the sense that they are quite sensitive to alternative (but reasonable) specifications of independent variables in estimating equations. The property value method of estimating benefits of air quality improvements was applied to Tampa data with weak and mixed results.

An estimate of morbidity costs versus costs of abatement equipment and the relative costs for each income class within a census tract was made by Loehman and Berg (1979). The survey employed the median values as representative of the samples drawn and then developed an aggregate and distributed cost and morbidity benefit analysis for the entire urban area surveyed. Their statement was as follows:

> Under this scenario the total population is 1,541,700 persons. Morbidity benefits are $14,686,375, and abatement costs are $7,560,181. The total morbidity benefits outweight the total abatement costs on a two-to-one basis. However, distributionally, in group 3 (Polk, Pascal, and Plant), abatement costs outweight morbidity benefits. However, redistribution of abatement costs could even out this distributional inequity. The decision for a control policy thus requires an applicable judgement as to who should bear costs and who should receive benefits. One possibility to gain acceptance of all groups would be to give group 3 a small share of abatement costs and group 1 a larger share (by about $2,000,000).

> One may guesstimate some corrections to our analysis as follows; on the cost side, approximate inclusion of indirect costs could be made by multiplying the direct costs by 1.5. On the benefit side, we may use the National Academy of Sciences National Research Council, Committee on Sulfur Oxides, "Air Quality and Automobile Emission Control," Volume I and II, U.S. Government Printing Office, Washington, D.C. (1974) to find a ratio of total benefits to morbidity benefits; then allowing for some indirect charges on benefits, one gets a multiplying factor of about 2. Accordingly, a slightly more favorable B to C ratio may be anticipated for the urban control scenario.

The attitude of the willingness-to-pay was examined among the people of Allegheny County, PA by Gregor (1977). He concluded that:

> ... individuals in Allegheny County are willing to pay approximately $7 million annually in order to maintain total particulate (TP) at a level 1% below those experienced during this 1968-72 period but only $.5 million annually for a similar percentage reduction in SO_2.

FUTURE TRENDS

All nonattainment areas in Southwest Florida are scheduled to comply with the air quality standards by 1982 (Florida State Department of Environmental Regulation 1980a). With the exception of major urban areas, future planned expansion of industrial and utility boilers is not expected to increase air pollution to the extend that there is any violation of State or Federal standards. On the other hand, the State's major utilities are seeking to convert from oil to coal 30% to 55% of the State's megawatt capacity in fossil-fueled power plants. If these conversions are authorized, and if emission levels authorized with the converted coal-fired utilities are less stringent than current oil-fired emissions, then the potential for massive increases of sulfur dioxides, nitrate oxides, and particulate matter threatens Southwest Florida. It is now impossible to estimate either the magnitude of the potential impacts, or the degree of further power plant conversions. These problems currently are under review by the appropriate private, State, and Federal institutions (Florida State Department of Environmental Regulation 1980a).

WATER POLLUTION

FLORIDA'S WATER QUALITY CLASSIFICATION SYSTEM

Federal and State Standards

Standards for all the designated classes of water within the State of Florida are Class IA potable surface water and Class IB potable groundwater. Class II is shellfish water and Class III is fish and wildlife and recreation waters. Class III is by far the largest class and includes over 90% of the State's surface waters. Class III marine standard is more appropriate for a

saltwater environment and Class IV is largely for self-contained agriculturally related irrigation and water retention systems. Class V is industrial and navigational classification, and Class VA is for surface waters (of which there is only one in Florida). Class VB is for industrial groundwater for such uses as deepwell injection of industrial wastes.

The specific parameters for each water classification vary according to use. They tend to become more stringent from the Class V Industrial to the Class I Potable. The Class I, II, and III outline stringent standards to protect human and aquatic life. Florida law requires that each body of water be classified according to its "highest and best use." Very few reclassification requests have been made or adopted since the surface and groundwater standards were established in Florida. Most of these standards are in the document on "Quality Criteria for Water" developed by the Criteria Branch of the Criteria and Standards Division in the Office of Water Planning and Standards (EPA 1976). Criteria are given for evaluating domestic water supplies, fresh waters for aquatic life, marine waters for aquatic life, and water for irrigating crops.

Groundwater Class V has a separate subcategory on aquifer systems. The threat of polluted aquifer is discussed in more detail later in this report.

Virtually all standards are based on tests on aquatic and land animal species (including human) response with a factor of safety applied to each standard. For example, the lethal concentration for 50% of the given, most sensitive, aquatic species is termed the LC50. If that number corresponds to 2 mg/l, then a factor (x 0.1) may be applied so that the EPA standard for an aquatic environment would be 0.2 mg/l.

> A report by the U.S. Environmental Protection Agency (1976) states that:
>
> Water quality criteria are derived from scientific facts obtained from experimental observations that depict organisms responsible to define stimulus of material under identifiable or regulated environmental conditions for a specified time period. The criteria levels of domestic water supply incorporated available data for human health protection. In some instances 1/100 of a concentration of the LC50 is employed while others 1/20 or 1/10 of the LC50 level constitute a safety factor.

These recommendations are based on scientific and professional judgement. These standards protect the life of all Floridians and visitors and maintain the propagation of aquatic and other life forms dependent upon aquatic environments. These are, therefore, tied to health, welfare, and well-being of all the citizens of the State.

The following paragraphs give a brief discussion of each classification and its particular level of compliance. Class III freshwater standards dominate the majority of interior wetlands including creeks, rivers, lakes, swamps, and other connected aquatic environments. Substantial differences can be expected betweeen water resources within the Class III designation due to difference in climate, geology, habitat, and land use. Since Class III waters

are so abundant, it is essential to limit the discussion to those areas where ongoing water quality analysis data are available. The major water courses in Southwest Florida and significant water quality violations within each designated major Class III system are discussed in the following paragraphs.

WATER QUALITY AND POLLUTION STANDARDS OF RIVERS (CLASS III)

As a group, the Class III major rivers and streams in Southwest Florida have relatively lower water quality than northwest and north central Florida streams. Dissolved oxygen (DO) concentrations in Southwest Florida streams range from a low of 2.8 mg/l in Weeki Wachee River, second lowest in the State, to a high of 7.6 mg/l in the Upper Alafia River. The lower Kissimmee, Myakka River, and Peace River all had organic nitrogen concentrations above 1.0 mg/l. The North Prong of the Alafia River had the lowest mean (1.6 mg/l) in the State. Ammonia varied from 0.08 mg/l in Weeki Wachee River run to 0.86 mg/l in the Little Wekiva River (highest mean concentration in the State). The highest concentrations of nitrates and phosphorus were in the Alafia, Peace, and Hillsborough Rivers. The Upper Alafia River had the lowest coliform density in the State (1,316/100 ml) whereas the North Prong of the Alafia River had the second highest coliform density (76,800/100 ml). Turbidity and suspended solid concentrations were low in most rivers. Most biological diversity values ranged from 2 and 3. Overall, streams in this region exhibited a wide range of water quality; however, major riverine systems such as the lower Peace, the Weeki Wachee, and Hillsborough Rivers generally had above average water quality.

Because of the central importance of these rivers in Southwest Florida, a brief summary of the most relevant water quality characteristics in each major watershed area is given in the following sections. These data are taken from publications of the Florida State Department of Regulation (1979a and 1979b).

Caloosahatchee River Basin

The Caloosahatchee River runs westward approximately 45 mi from the Moore Haven Locks on Okeechobee Lake to the Franklin Lock on Lake Okachopatee and then about 30 mi into an estuary system of the Gulf of México. Land use in the Caloosahatchee Basin is dominated by agriculture and wetlands. Intensive truck gardening there requires heavy application of biocides and fertilizers which indirectly affect water quality. The City of Fort Myers is located on the Caloosahatchee River approximately 15 mi from the gulf. Major sources of pollution include sewage effluent, industrial point source, and runoff from rangeland, agricultural land, and urban areas. Nutrient concentrations downstream from LaBelle vary greatly but sometimes are excessive. Concentrations of total phosphorus and NO_3-NO_2 also was high in some areas. Dissolved oxygen (DO) averages near State standards for most of the river's length. Violation of water quality standards for DO, pH, mercury, cadmium, lead, and total alkalinity are common in the Caloosahatchee River. A comparison of historical and recent data indicates no overall temporal trends. In general, water quality in the Caloosahatchee River is sometimes serious, but not critical.

Peace River Basin

The Peace River basin is drained by the Peace and Myakka Rivers which empty into Charlotte Harbor. A brief discussion of each follows:

The Peace River originates in the Green Swamp in Central Polk County and flows southwesterly for about 105 mi into the Gulf of Mexico at Charlotte Harbor. The Green Swamp serves as an important recharge area for the Florida aquifer because of numerous lakes and large areas of poorly drained swamps. The Green Swamp itself, because of high recharge characteristics, has been designated as an Area of Critical State Concern. Land use in the upper portion of the Peace River basin is predominantly agricultural, but a large percentage (25%) of barren land supports extensive phosphate mining along the river.

Major pollution sources are domestic sewage discharge, heavy industrial discharges from phosphate mining activities, chemical plants, citrus processing plants, and surface runoff. Total Kheldahl nitrogen (TKN) levels are high throughout the river. Mean concentrations vary from a high of 2.26 mg/l at Bartow to a low of 0.86 mg/l near the mouth. Average total phosphorus concentrations show a similar downstream decrease from a high of 3.08 mg/l to a low of 0.66 mg/l. Mean pH values gradually increase from 6.8 in the upper reaches of the river to 7.9 at the mouth. Relatively low DO concentrations (4.4 mg/l), sometimes below the State water quality standard, have been reported throughout the Peace River.

The diversity of macroinvertebrates (usually the greater the diversity, the lower the pollution) is reasonably good in the downstream portion of the Peace River. High nutrient and fecal coliform levels and low concentrations of DO in the upper portions of the Peace River are thought to be related to discharges of sewage and industrial effluent in the area. An increase in fecal coliform counts and a decrease in pH and total phosphorus values has been observed in recent years. In general, the water quality in the Peace River improves downstream. In the lower reaches, the water quality is good.

The headwaters of the Myakka River are the freshwater marshes in Hardee County in southwestern Florida. A salt wedge extends far upstream in Charlotte Harbor during periods of low flow. Rangeland (45.6% of the total area) and agriculture (26%) are the major land uses in the river basin. The major source of pollution is surface runoff from agricultural and pasture lands. High levels of total phosphorus (0.23 to 0.39 mg/l) has been reported throughout the river. Fairly low concentrations of DO are common in the upper portion of the river (a minimum of 3.8 mg/l) and frequently fall below the State water quality criteria at Sarasota. Concentrations of cadmium, lead, and mercury sometimes exceed the State water quality standards in the Myakka River near Sarasota. Average fecal coliform counts are relatively high below Sarasota (297/100 ml) and at Snook Haven Dock. Macroinvertebrate diversity is reasonably good throughout the river. No overall temporal trend in water quality is evident. In general, the river water quality is good.

The Tampa Bay River Basin

The Tampa Bay Basin, which encompasses 3,000 mi^2 in four major drainage areas, includes Tampa Bay, Withlacoochee River (including Pitchlachascotee,

Anclote, and Crystal Rivers), the Hillsborough River Basin, the Alafia River Basin, and the area between Myakka River and the Alafia River. The major metropolitan areas are Tampa, St. Petersburg, Clearwater, Sarasota, and Bradenton. Each of the river basins is described in the following subsections.

Pitchlachascotee, Anclote, and Crystal River Basins. The Pitchlachascotee River originates in Hernando County, Florida, and flows about 41 mi southwest to the Gulf of Mexico at New Port Rickey. About 15% of the average flow of the river is supplied by the Floridian aquifer. Land use is primarily agricultural, and New Port Rickey is the only urban area. Violations of State water quality standards for dissolved oxygen and pH are common. Data indicate no overall temporal trend in water quality. Within the Pitchlachascotee drainage, water quality is usually good or very good. The Anclote River originates in south-central Pasco County and flows westward approximately 27.5 mi to the Gulf of Mexico. The major land use in this area is agriculture. Water quality standards of pH and DO concentrations in the south branch often are violated, and total alkalinity, pH, and mercury concentrations occasionally fall below State standards. Macroinvertebrate diversity at the mouth of the Anclote River is reasonably good. The Crystal River originates from a group of springs at Kings Bay and flows approximately 6 mi to the Gulf of Mexico. Little change in water quality of the Crystal River has been reported; generally, the water quality is very good.

Hillsborough River Basin. The Hillsborough River flows southwesterly for about 55 mi from the Green Swamp area in Pasco County to Hillsborough Bay. The principle tributaries are Trout Creek, Blackwater Creek, and Six Mile Creek. The Hillsborough River provides the potable water supply for Tampa. The primary sources of pollution are urban and agriculture runoff, domestic sewage (8 Mgal/d) and industrial discharges (11.5 Mgal/d), primarily from citrus processing plants.

Surface runoff and domestic sewage are the major pollution sources in the southern stretch of the river. Moderately high levels of TKN occur near the headwaters of the Hillsborough River (0.915 mg/l). Total phosphorus values are high throughout the river (0.320 to 0.068 mg/l). Itchepachesassa Creek, a tributary to Blackwater Creek, receives wastes from several citrus industries. The high phosphorus and nitrate-nitrite levels may be caused by the various industrial discharges into Blackwater Creek. Mean DO concentrations are very low (0.32 mg/l) near the headwaters, but increase to 6.5 mg/l in mid-reaches. DO concentrations below State water quality criteria are frequently reported throughout the river. This may in part be due to natural Green Swamp drainage and tidal influences.

Concentrations of cadmium, lead, and mercury above the State water quality standards have been detected in the Hillsborough River near Zephyrhills, in Trout Creek, and in Tampa urban area. Levels of fecal coliform bacteria are high near Blackwater Creek (961/100 ml) and extremely high (5,480/100 ml) near Tampa. These concentrations are 4 to 27 times greater than the 200/100 ml State standard for Class I Potable water supplies and are caused mostly by domestic sewage. Macroinvertebrate diversity is good, especially in the upstream undeveloped areas. Average concentrations of TKN and total phosphorus have declined in recent decades whereas substantial increases in nitrate-nitrite concentrations and fecal coliform counts have increased. No overall

temporal trend in water qualities is apparent. Water quality in general is fair, sometimes poor, especially since the river is designated as a potable water supply.

Alafia River Basin. The Alafia River, located in Hillsborough and Polk Counties, flows westward 24 mi into the Hillsborough Bay. Major tributaries are the North Prong, South Prong, and Little Alafia Rivers. Land use in the basin is largely agricultural (35%), range (17%), and barren lands (12%). The river flows through areas of extensive phosphate mining and rock processing. Industrial sources, primarily phosphate, discharge an average of 63 Mgal/d of wastewater into the Alafia River. Additional sources of pollution include runoff from mines, pastures, and agricultural areas. Occasional slime spills from phosphate processing operations. TKN values are high in the headwaters of North Prong and the Alafia Rivers. Phosphorus concentrations are high in the headwaters but decline downstream. Nitrate-nitrite concentrations also are very high but decrease progressively downstream. In the main stem of the river, DO decreases to extremely low levels for about 5 mi. The Alafia River rarely meets Class III standards for DO in this reach of the river. Concentrations of cadmium and mercury greater than State standards have been detected in the North and South Prongs.

High concentrations of lead have been reported at Lithia in Hillsborough County and high levels of fecal coliform bacteria (1,010 to 5,150/100 ml) have been reported for all of Alafia River. This may be due to the abundance of cattle in the intensively grazed pasture leands along the river. Nitrogen and fecal coliform levels have increased and DO concentrations have decreased in recent decades. In all, organic loading may be responsible for the decline of water quality in recent years. Conversely, phosphorous concentrations have declined. In general, water quality in the Alafia River Basin is fair in the upper reaches of the South Prong, and poor in the North Prong and Alafia Rivers.

Manatee River Basin. The headwaters of the Manatee River flow approximately 25 mi southwesterly into Tampa Bay from the northeastern corner of Manatee County. This river is impounded at Lake Manatee to provide the drinking water supply for Manatee County. Downstream from Fort Hammer, the Manatee River is influenced by tides. Principle tributaries of the Manatee River are Braden River and Gamble Creek. Land uses are primarily agricultural (38%) and rangeland (41%). Bradenton and Palmetto are the major urban areas. Sources of pollution include domestic sewage and surface water runoff from rangeland and agricultural lands. Concentrations of total phosphorus are relatively high (0.26 to 0.52 mg/l), but water quality generally is good throughout the system which is characterized by low concentrations of TKN, nitrate-nitrite, and fecal coliform. In recent years concentrations of total phosphorus and nitrate-nitrite have declined. In general, water quality in the Manatee River basin is very good.

Withlacoochee River Basin. The Withlacoochee River originates in the Green Swamp near the junction of Lake and Polk Counties, and flows in a northwesterly direction for about 157 mi through Polk, Pasco, Hernando, Sumter, Citrus, Marion, and Levy Counties and discharges into Withlacoochee Bay at Yankeetown. A major portion of the flow is contributed by the Florida aquifer. The river basin contains numerous lakes and springs, and the river is impounded for hydro-electric power at Inglis near the gulf in Citrus County.

Land use in the basin is primarily agricultural (38.9%) and barren land (8.9%). The latter reflects the limerock mining activities in the Lower Withlacoochee River Basin. Surface runoff and industrial and domestic sewage are the primary sources of pollution. Major urban areas are Inverness, Brooksville, and Dade City. The acid swamp drainage that forms the headwaters of the Withlacoochee influences downstream water quality. Average DO concentrations are somewhat low (4.3 mg/l) near the headwaters, but increase only slightly downstream (5.6 mg/l). Measurements below the State standard of 5.0 mg/l have been frequently reported throughout the river. Average pH values in recent years have increased from 4.7 to 7.5. Heavy metal concentrations of cadmium, lead, and aluminum in excess of State water quality standards have been detected. Mean fecal coliform levels are low throughout the Withlacoochee River and no consistent temporal trends in water quality are apparent. In general, the water quality in the Withlacoochee River Basin is good.

WATER QUALITY IN ESTUARIES (CLASS II, III)

Saltwater (brackish) Class III waters are suitable for saltwater species of aquatic life and for water-related recreation. Class II is designated solely for shellfish propagation. The acceptable limits of Class II often is far more restrictive than Class III because of the filter-feeding nature of shellfish and threat to public health. In polluted areas, shellfish consume pollutants, some of which accumulate in their body tissues to levels that can endanger human health if consumed (Lynch 1981).

Water quality, based on concentrations of nitrates-nitrites, ammonia, phosphorus, fecal coliform bacteria, and nutrients, and on benthic diversity, generally has been good in Southwest Florida estuaries. The major coastal estuaries in the network of stations monitored in 1977-79 were Tampa Bay, Charlotte Harbor, and Florida Bay areas. Estuaries in central Florida (Tampa Bay) generally had average water quality, whereas water quality in Charlotte Harbor generally was above average; consequently, neither is an immediate threat to public health or the aquatic environment. Pennekamp Park had the lowest total organic carbon (average 3.5 mg/l) and chlorophyll A (less than 110 micrograms per liter). It also had the highest diversity in the State, averaging 5.19.

Dissolved oxygen concentrations were good in all estuaries, ranging from 6.0 mg/l in the Peace River estuary to 7.5 mg/l in Hillsborough Bay. Biological oxygen demand (BOD) also was high, up to 4.0 mg/l in Hillsborough Bay. Nutrient concentrations were generally low in most estuaries. The exceptions are given later. Hillsborough Bay had the highest ammonia concentration in the State (0.28 mg/l) whereas other estuaries averaged less than 0.13 mg/l. High phosphorus concentrations were evident in Hillsborough Bay (1.24 mg/l), Middle Tampa Bay (0.78 mg/l). Coliform counts generally followed trends similar to phosphorus. The four stations in Hillsborough and Tampa Bays had higher fecal and total coliform counts than most other stations in Florida estuaries. Hillsborough Bay had the highest average fecal and total coliform counts (490/100 ml and 3,250/100 ml, respectively) in Southwest Florida.

Turbidity was low (4 JTU's) in Southwest Florida estuaries and total organic carbon and chlorophyll A concentrations generally were high. Organic carbon ranged from 6.7 to 12.0 mg/l. Hillsborough Bay had the highest average

(25 mg/l) chlorophyll A concentration in the State. Tampa Bay was the only estuary in the area with a concentration less than 5 mg/l.

All estuaries except Hillsborough Bay and Peace River had benthic diversity values above 3.1. Tampa Bay had the highest diversity (3.95) in central Florida. Estuaries in Southwest Florida generally had average to good water quality. The Hillsborough Bay and Peach River tidal zone had the poorest water quality in the area.

The most serious water quality problems are in the Greater Tampa Bay area. The following discussion examines the nature and extent of the water quality problems there.

Tampa Bay is a large shallow estuary with low tidal flushing, especially in the Old Tampa Bay area. The tides rarely exceed 2 ft because of a rather extensive causeway system. For water quality assessment, Tampa Bay is divided into East Tampa Bay, including Hillsborough Bay and the eastern half of Tampa Bay proper, and West Tampa Bay including the western half of Tampa Bay from the mouth northward, and Old Tampa Bay. Land use in the area adjacent to the Bay is primarily urban, and major sources of pollution come from domestic sewage, industrial effluents, and urban stormwater runoff from the metropolitan areas of Tampa, St. Petersburg, Clearwater, and Bradenton.

In Old Tampa Bay, concentrations of total phosphorus average between 0.73 to 0.81 mg/l, and peak at 0.91 mg/l. From this point to the entrance of Tampa Bay southward, high concentrations of phosphorus are evident. A similar trend is evident for concentrations of TKN, nitrate-nitrite, and fecal coliform bacteria. High dissolved oxygen concentrations and high pH are typical. Although somewhat variable, macroinvertebrate diversity in Old Tampa Bay is reportedly good. Violations of total and fecal coliform bacteria standards are rare. Water quality in West Tampa Bay in recent years has improved. Concentrations of total phosphorus, NO_3-NO_2, TKN, and fecal coliform have decreased substantially. This improvement in water quality is especially notable where Old Tampa Bay and Hillsborough Bay meet.

In East Tampa Bay, concentrations of total phosphorus are high and average about 1.4 mg/l near Hooker Point in Hillsborough Bay, and 1.5 mg/l in that portion of Tampa Bay near the Alafia River. A similar spatial distribution was shown by fecal coliform counts. High counts were recorded for the upper portions near the Alafia River (677/100 to 12,500/100 ml) and low fecal coliform counts at the entrance to Tampa Bay around 109/100 to 116/100 ml. The State standard of 200/100 ml for fecal coliform sometimes has been exceeded occasionally in East Tampa Bay. Broad macroinvertebrate diversity was reported, which suggests rather low levels of general pollution. Recent studies indicate a general improvement in water quality in the East Tampa Bay, particularly in the area of Hillsborough Bay. Trends suggest that water quality has improved throughout East Tampa Bay near the Alafia River. Water quality generally appears to be good in the southern portion of East Tampa Bay, and fair in the Hillsborough Bay area. The better water quality in West Tampa Bay is somewhat higher than in East Tampa Bay.

Hazardous Wastes

Hazardous wastes are a problem in Florida largely because of their direct effects on highly valued aquatic ecosystems and groundwater aquifers. High porous sandy soils rapidly transport surface waters (some of it contaminated) into the aquifer and, consequently, create serious problems for the disposal and treatment of hazardous wastes. Several of these problems have had far reaching effects.

Frequent oil spills along the St. Marks River and in its port waters caused an annual loss of $328,000 to the sport and commercial fishery (Bell 1981). Another analysis showed that heavy metals and sulfuric acid from a battery reclamation facility caused $6 million in damage to the environment, including the cost of reclamation. In addition, freshwater fishery losses were extensive in Dry Creek, Chipola River, and Gulf County Dead Lakes area (Lynch 1981), and possibly as far downstream as Apalachicola Bay.

The cost of pollution of groundwater has not been estimated, but freshwater wells near the sources of contamination contained heavy metal and organic concentrations above EPA standards.

A number of hazardous waste incidents in Florida have been identified (Florida State Department of Environmental Regulations (1980b). The most serious incidents were groundwater contamination by a reclamation operation, disposal of infectious wastes, oil spills, and pesticide/oil mixture contamination. Some of the details are given in the following subsections.

Pesticide/oil spill. A pesticide/oil mixture contaminated the Orange River in 1977, when Lee County mosquito control personnel spilled about 500 gal of oil, water, and pesticides (Baytex, Cythion, Malathion) into a ditch that later was flushed into the Orange River by heavy rains. Some fish were killed and about $15,000 was spent for cleanup. (Refer to the Data Appendix, Table EIR 3 for additional information.)

Fish kill, Exxon Co., Lehigh Acres, Lee County. In 1976, a leak developed in a pipeline serving an oil well on Exxon property at Lehigh Acres and some of the fluid drained into a canal. In the cleanup, an estimated 23,400 gal of oil and water mixture were recovered; the 1,400 gal not recovered flowed into the canals adjacent to Lehigh Acres. More than 3,000 fish were killed, and the invertebrate population and aquatic vegetation in the canals were contaminated. The cost of cleanup was $47,000; the fines and damages exceeded $14,000.

Oil spill in Tampa Bay. In 1977, an oil-carrying barge collided with the Tampa Electric Co. dock and was badly damaged. The barge leaked about 110,000 gal of light diesel fuel into Sparkman Channel in Tampa Bay. Many injured and dead waterfowl, predominantly ducks, of which more than 65 were dead and approximately 30 were coated with oil, were counted. Other injuries to aquatic life were apparent in the marshes but they were not counted. Cleanup costs exceeded $100,000 and penalties could reach $55,000.

Florida Keys oil spill. In July 1975, possibly as much as 120,000 gal of crude oil was discharged from a tanker carrying fuel oil when it cleaned its tanks off of the Florida Keys coast. Incalculable damage was done to exten-

sive mangrove areas from Key Largo to Key West, and invertebrate life on beaches along the Atlantic coast of the Florida Keys. The cost of the cleanup operation was over $367,430. The owners and the captain of the offending vessel could be fined as much as $15,000.

Industrial related hazardous wastes incidents. The groundwater was contaminated by a battery plant in Hillsborough County owned by the Gulf Coast Lead Co. which in 1978-81 regularly discharged sulfuric acid, nickel, chromium, cadmium, lead, copper, zinc, barium, and strontium. The DER and EPA required Gulf Coast Lead Co. to monitor groundwater for contamination. Nearby wells were not contaminated, but water in the company monitoring wells had excessively low pH and high heavy metal concentrations. No remedial action for construction of stormwater drainage and acid neutralization systems is currently underway. (Data Appendix, Table EIR 7, contains additional information.)

Improper disposal of infectious wastes. In 1980-81 infectious materials of the "red bag" variety from area hospitals, veterinary clinics, and other medical facilities in Hillsborough and Pinellas Counties have been incinerated. Materials included soiled bandages, hypodermic needles, blood samples, and other infectious wastes, but because of deficient incinerator capacity, some materials are buried in landfills. Proper handling and discharge of these hazardous wastes have been directed by officials of the St. Petersburg Department of Environmental Sanitation and is proceeding at this time (further information is available in the Data Appendix, Table EIR 8).

The list of sites in EIR Table 10, "Inventory of Potential Hazardous Wastes Sites by County" in the Data Appendix lists the most serious hazardous waste facilities in the State. The Tampa Bay area contains the largest number of potential hazardous waste sites identified by the Hazardous Waste Section of the DER and rated by "Mitre" score from least to most serious risk. The Tampa Bay facilities are typically in the mid-range with values from 40 to 55. Hillsborough County has one facility, Schylkill Metals in Plant City, that is ranked (59) more serious than all of those in Tampa. These scores reflect the professional judgement of the interdisciplinary DER and EPA staffs that assembled to rank the potential sites and their degree of risk to the environment.

FISHERY LOSSES

As a peninsular state, Florida possesses large areas of high quality fresh and salt waters. The State's economy and its $19 billion tourist industry is linked to and dependent upon the quality of the State's natural resources with special importance attached to the quantity and quality of fresh water.

The total value of Florida's tourist trade in 1980 was $19 billion in tourist related expenditures and over $785 million in State revenues. Water pollution in Florida reported by Bell and Canterbury (1976) has decreased the value of the tourist industry by 8%.

The freshwater sport fishing in 1975 was valued at over $1 billion and directly and indirectly supported about 75,500 jobs. If pollution were reduced as set forth in the Clean Water Act, the man-days of sport fishing alone

should increase about 90% by 1985 (from 55 million in 1974 to 105 million in 1985), independent of the population increase. The nonmarket value of the sport fishery probably would increase by about $133 million.

The saltwater sport fishery, on the same basis, had a value of $2 billion and supported 118,000 jobs (Bell 1979). The commercial saltwater fishery supports 36,262 jobs and an industry worth about $160 million per year.

An estimate of the dockside value of the marine landings in the counties of Florida are given in Figure 1. The average annual value of the fisheries yield was between $5 and $8 million in Sarasota, Charlotte, and Monroe Counties, between $1 and $5 million annually for Pinellas and Hillsborough Counties, and between $0.5 million and $1 million for Manatee and Collier Counties. This income is a major part of the local economies of these counties. For further details on sport fishing, consult the synthesis paper on recreation and tourism in this report.

Potential catch increases in the Class II-dependent shellfishery area were examined by Bell and Canterbury (1976). This study sponsored by the National Commission on Clean Water, forecasts that if goals of the Clean Water Act are met in Florida, landings from estuarine and Class II-dependent fishery areas would increase from 1972 to 1980 by 10.5 million lb for lobster, 15,2 million lb for oysters, 765,000 lb for scallops, 8.9 million lb for crabs, and 19.7 million lb for shrimp. Menhaden are expected to increase by almost 14 million lb because of improvements in water quality.

The relative value of wetlands and Class II fishery areas can be estimated through economic methodology. A study on the marine estuarine resources of Northwest Florida was completed for the Army Corps of Engineers, Mobile (Edmunsten 1977). This survey covered the eight coastal counties from Escambia County east to Wakulla County, but is applicable to Southwest Florida as well. Fifteen estuaries were identified including the major Class II areas. In a study by Bell (1977) the average value per acre of estuary was $60.91. Another study completed by Gosselink et al. (1973) gave a value of $75.00 per acre of estuary. Bell estimated that $13.83 per acre may be lost in Class II estuaries of Santa Rosa County if the Navarre Pass reopens (Bell 1977).

Other estimates of pollution impacts verify the high value of fisheries. One researcher (Terbonne 1973) estimated that fishery losses from water pollution alone in the Pensacola area in 1972 were over $3 million. The initial effects on fisheries can further be magnified throughout the economy by multiplier effects.

FORECAST AND TRENDS

Attempts have been made in several publications to correlate water quality in rivers, lakes, and estuaries with point and nonpoint water pollution and to forecast conditions and problems. One of the most useful analyses was made in Section V of the Water Quality Assessment (Florida State Department of Environmental Regulation 1979a) report on "Statistical Analysis of Water Quality Versus Point and Nonpoint Sources." The significance of the comparisons were made by determining correlation coefficients in an attempt to establish pollution loadings and levels and future forecasts. Coefficients among the

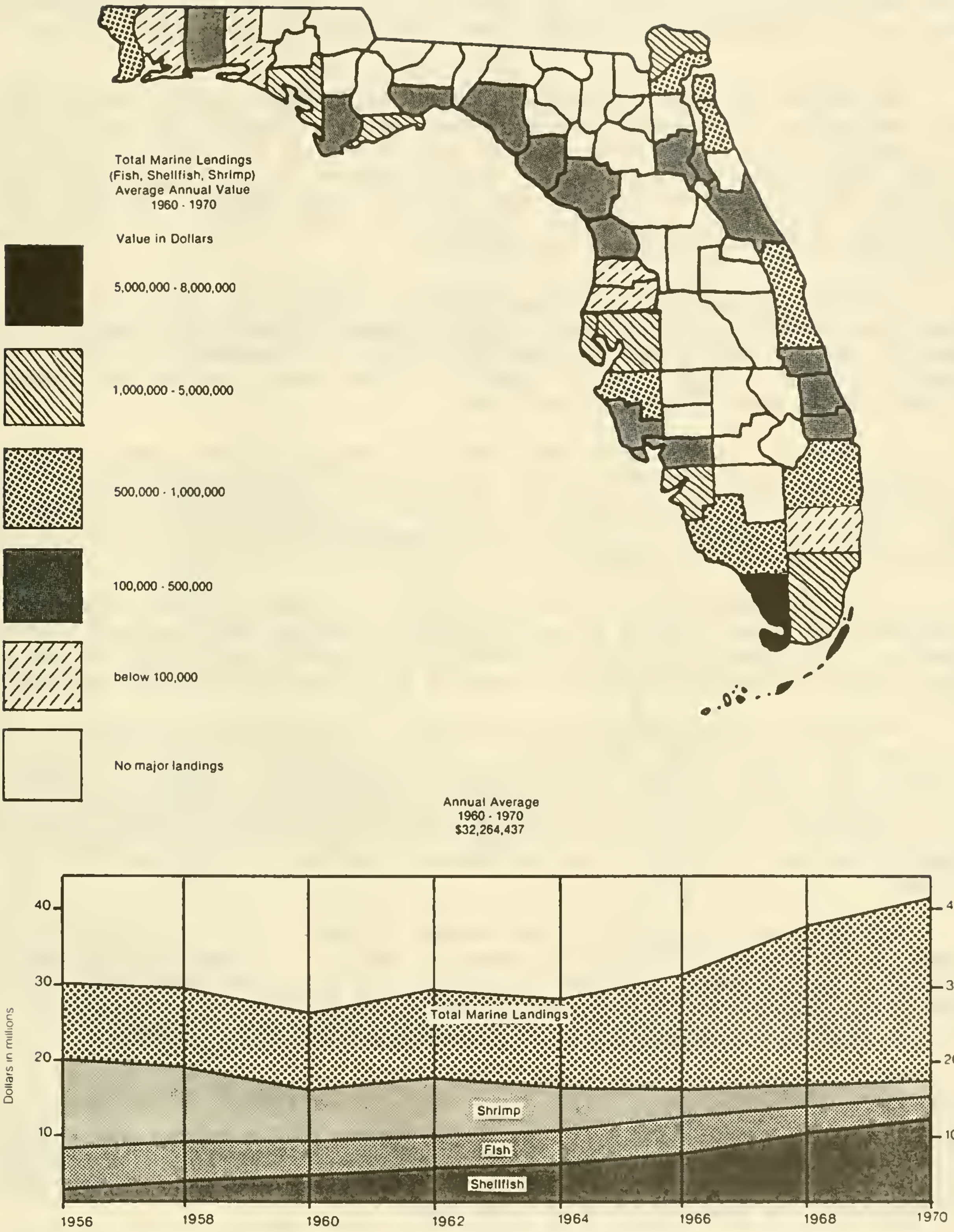

Figure 1. Marine landings for Florida in 1970 (Wood and Fernald 1974).

paired values were statistically significant (0.74) at the 95% confidence level. Point source and nonpoint source and urban concentrations typically show positive correlation with low water quality. Not all water pollution is explained by watershed conditions alone; many other factors are involved as well.

The water assessment report also developed a water quality index (WQI) and a watershed index (WSI) that describes the relationships between changes in standard values of all water quality measurements as a function of land-use types in a watershed. Phosphorus concentrations in aquatic habitats and intense industrial areas such as strip-mining, urban centers, and rangeland exhibited a positive correlation. Watersheds with relatively high sewage flows also exhibit an abundance of phosphorus.

Nitrogen concentrations (TKN and organic nitrogen) were highest in rangelands and wetlands with high water storage capacity, and high in waters subject to sewage discharges. Inorganic nitrogen is somewhat different from organic nitrogen. High levels of organic nitrogen appears to have been caused by fertilizers used on agricultural lands.

An increase in the area of urban and rangelands, and sewage inflow, caused an increase in the biological oxygen demand (BOD) in the waters of the watershed. Raw sewage particularly increases the probability of excessive BOD. Dissolved oxygen in rivers and ponds apparently was little altered by runoff from wetlands and rangelands.

Increased urbanization, industrialization, and water-related development indicate that water quality in some areas will decline over the next several decades. The degree of decline is difficult to predict accurately and therefore should be identified only in terms of direction and probable magnitude.

Phosphorous concentrations and nitrogen concentrations probably will increase as agriculture intensifies. As urbanization expands, forests are cleared and marsh wetlands are drained so that BOD, DO, inorganic nitrogen, and phosphorous are likely to increase. On the other hand, regulatory controls including point source discharge permits and regulatory management of nonpoint source discharges should minimize violations of water quality standards.

The best available forecast for sewage treatment plant discharges in the counties of Southwest Florida is shown in Table 2. Increased point source loadings from secondary treatment facilities and associated industrial expansion and coastal developments are strongly related with declines in water quality (Florida State Department of Environmental Regulation 1979a).

The increase in sewage treatment facilities is somewhat in proportion to the increase in population. The rates of growth (3.1% to 5.7%) among the counties of Southwest Florida are among the highest in the State. The population distribution throughout the State are given in Figure 2. The greatest single concentration is in the Tampa or St. Petersburg area. Future increases probably will be greatest south of Tampa Bay.

Considering the increase in the population, the increase for sewage treatment also will grow and further stress some of the natural resources (Florida State Department of Environmental Regulation 1979a).

Table 2. Sewage treatment capacity needs (Mgal/d) and costs ($ millions) for the year 2000 (Florida State Department of Environmental Regulation 1981).

County	Average annual population growth rate[a] (percent)	Growth in design capacity (Mgal/d)	Number of new facilities[b] expected	Single[b] plant capital costs	Estimated total[c] capital costs
Charlotte	5.7	10.58	146	12.25	55.75
Collier	5.7	13.71	179	14.67	70.98
DeSoto	3.3	1.41	13	3.01	6.54
Hillsborough	3.9	100.53	207	58.71	296.93
Lee	5.7	67.15	398	44.33	273.55
Manatee	3.0	13.16	74	14.41	53.21
Monroe	3.1	6.78	119	3.99	38.47
Pasco	3.9	15.81	141	16.20	72.99
Pinellas	3.9	209.09	107	97.73	404.41
Sarasota	5.7	39.17	197	30.46	151.79
Florida	N.D.	1,366.82	4,243	936.04	4,007.72

[a] Based on the University of Florida Bureau of Economic and Business Research, Population Divisions forecast.
[b] Assumes historical mean for each county.
[c] Assumes that total capacity is one plant using EPA construction costs curve (cost = 1.77 [design] 0.096) in 1981 dollars.

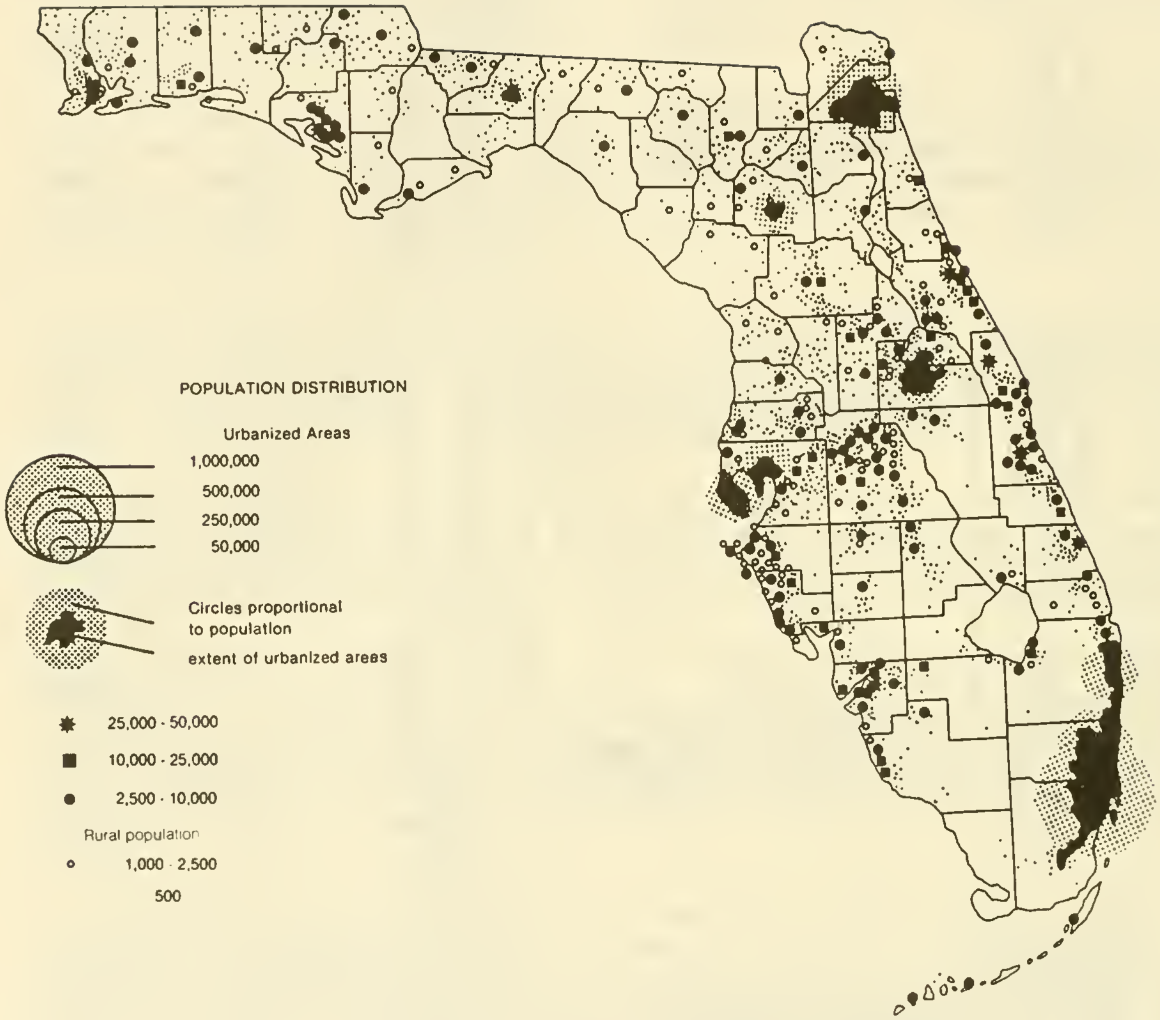

Figure 2. Population distribution in 1970 (Wood and Fernald 1974).

Those counties with phosphate deposits are shown in Figure 3. Hillsborough, Manatee, and Sarasota Counties hold phosphate deposits that are likely to be mined in the future. Demands for mining sites and increased urbanization are sure to be competitive. Mining will probably continue to affect water quality by contaminating freshwater runoff. The synthesis paper on mineral resources gives more information on mining forecasts in Southwest Florida.

The percentage change of land in farms for 1950, 1959, and 1969 are given in Figure 4. Although agriculture is important to the region's economy, it is losing to urban development in the coastal counties. The loss of agricultural lands has been compensated for by intensifying productivity. This trend is expected to continue into the future. Agriculture still has a major influence on water quality and quantity throughout Florida because it uses so much water for irrigation. Agricultural trends in Southwest Florida are further described in the chapter on agriculture in this report.

CLASS I DRINKING WATER

FEDERAL AND STATE STANDARDS

The Federal Safe Drinking Water Act of 1974 (P.L. 93-523) instructs the U.S. Environmental Protection Agency to establish regulations for safe drinking water. The State of Florida has taken the Federal guidelines and incorporated them into the Class I water quality criteria discussed earlier in this report. These standards establish the minimum criteria required for safe drinking water from ground (Class IB) and surface (Class IA) water supplies. A Class IB underground source of drinking water is an aquifer or part of an aquifer that supplies water suitable for drinking and contains fewer than 10,000 mg/l of total dissolved solids (most ground water in Florida has less than 250 mg/l of dissolved solids). About 92% of the State's residents depend upon aquifers for a source of potable water. In Southwest Florida, citizens are largely dependent on the Floridian aquifer (the State's largest) and shallow sand-and-gravel aquifers. Part C of the Federal Safe Drinking Water Act (P.L. 92-523) establishes guidelines for State programs to protect underground drinking water sources. Regulations are designed to protect present and future supplies.

The potential pollution sources that most threaten the State's potable groundwater are discharges of municipal and industrial wastes. Even surface runoff sometimes is contaminated by waste disposal practices (Figure 5).

To protect Florida's valuable groundwater resources, the State has enacted a series of regulatory programs. The most important one is an under ground injection control. This program is designed to ensure that injected fluids from Florida's 6,858 injection wells stay in the intended injection zone and do not migrate into drinking water supplies. An annotated list of the major types of subsurface aquifers and the general characteristics of the five classes of underground injection wells regulated within the State are given in Figure 6.

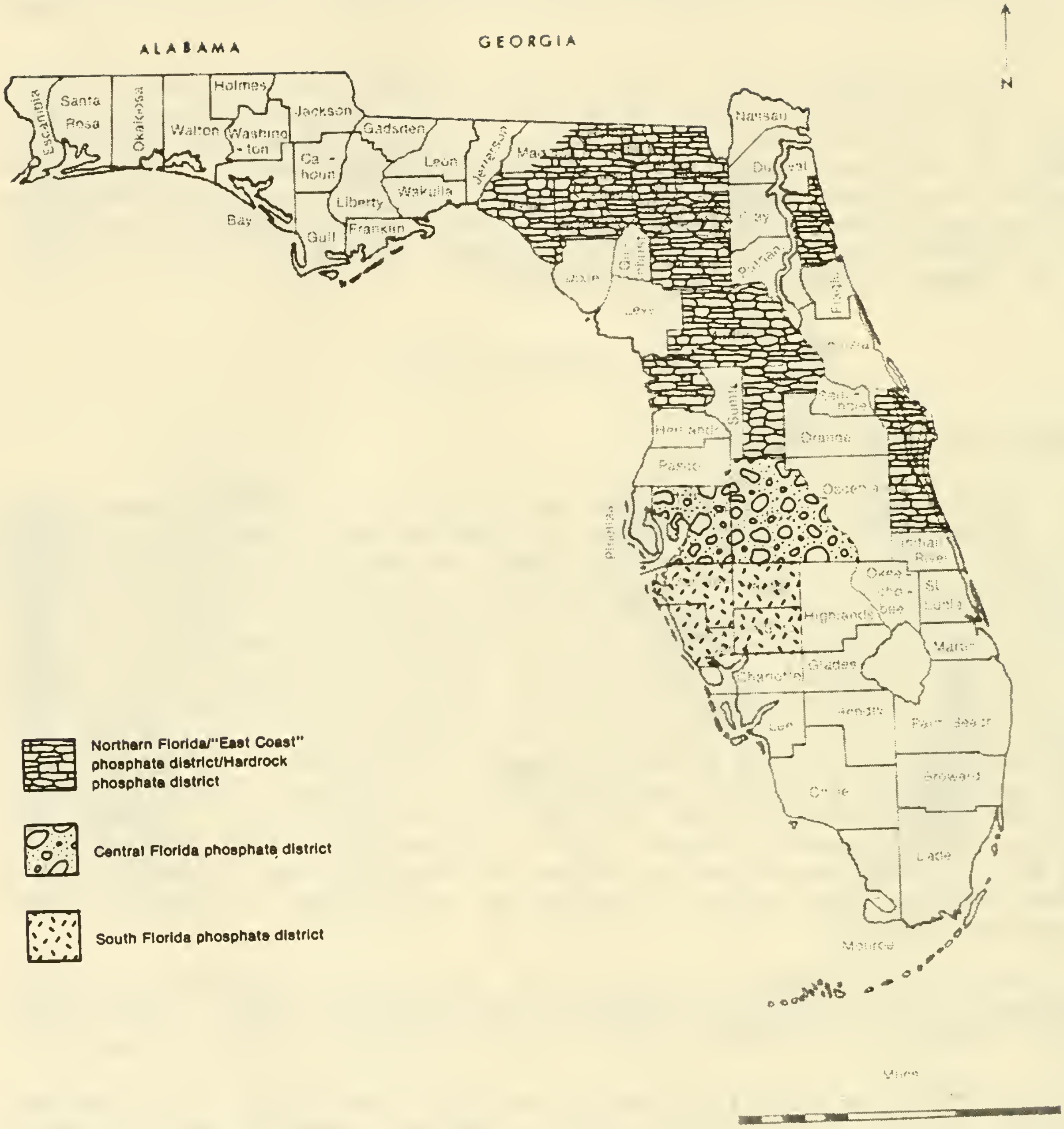

Figure 3. Florida counties with identified phosphate deposits (Zellars-Williams 1978).

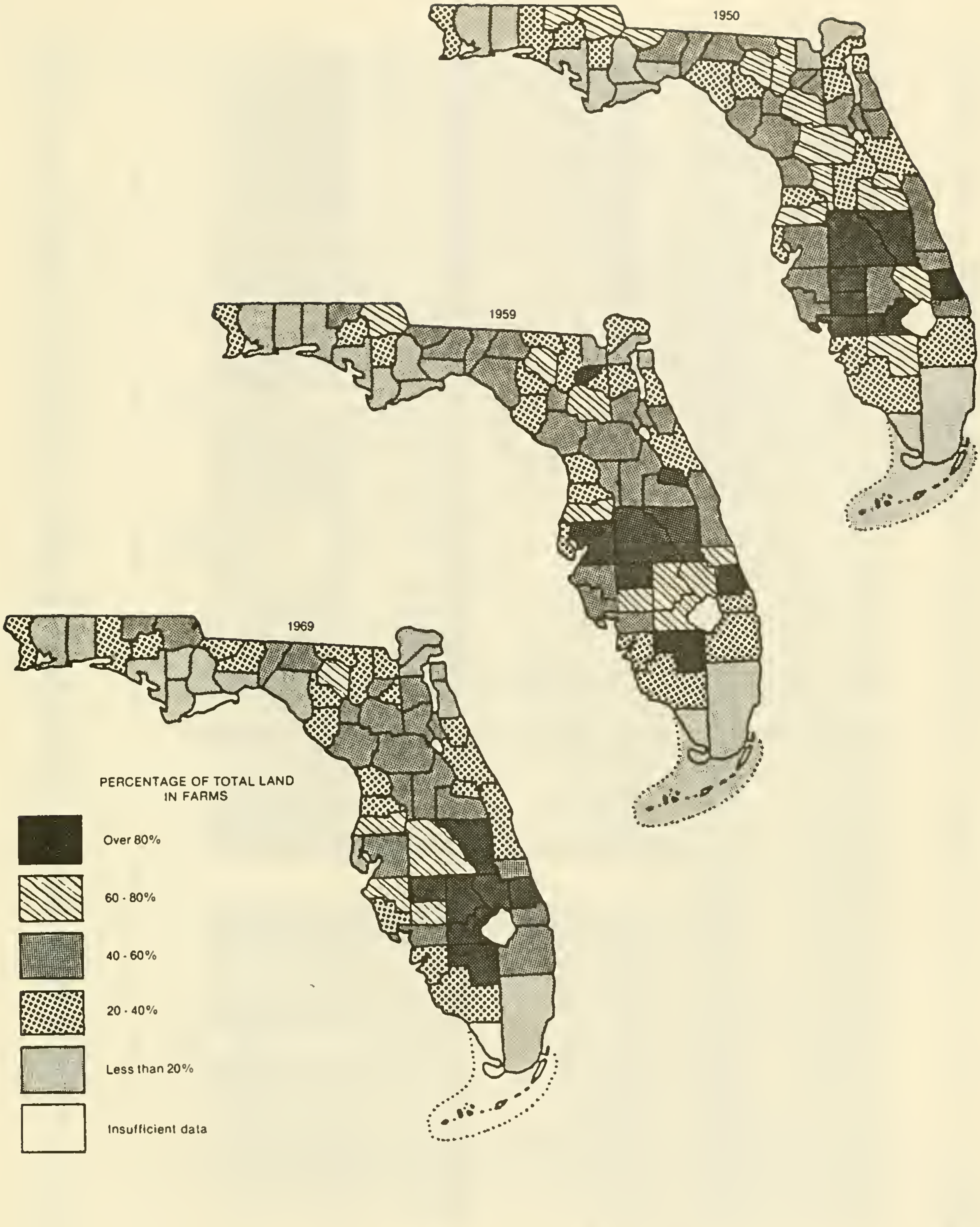

Figure 4. Changes in percentage of land in farms for 1950, 1959 and 1969 (Wood and Fernald 1974).

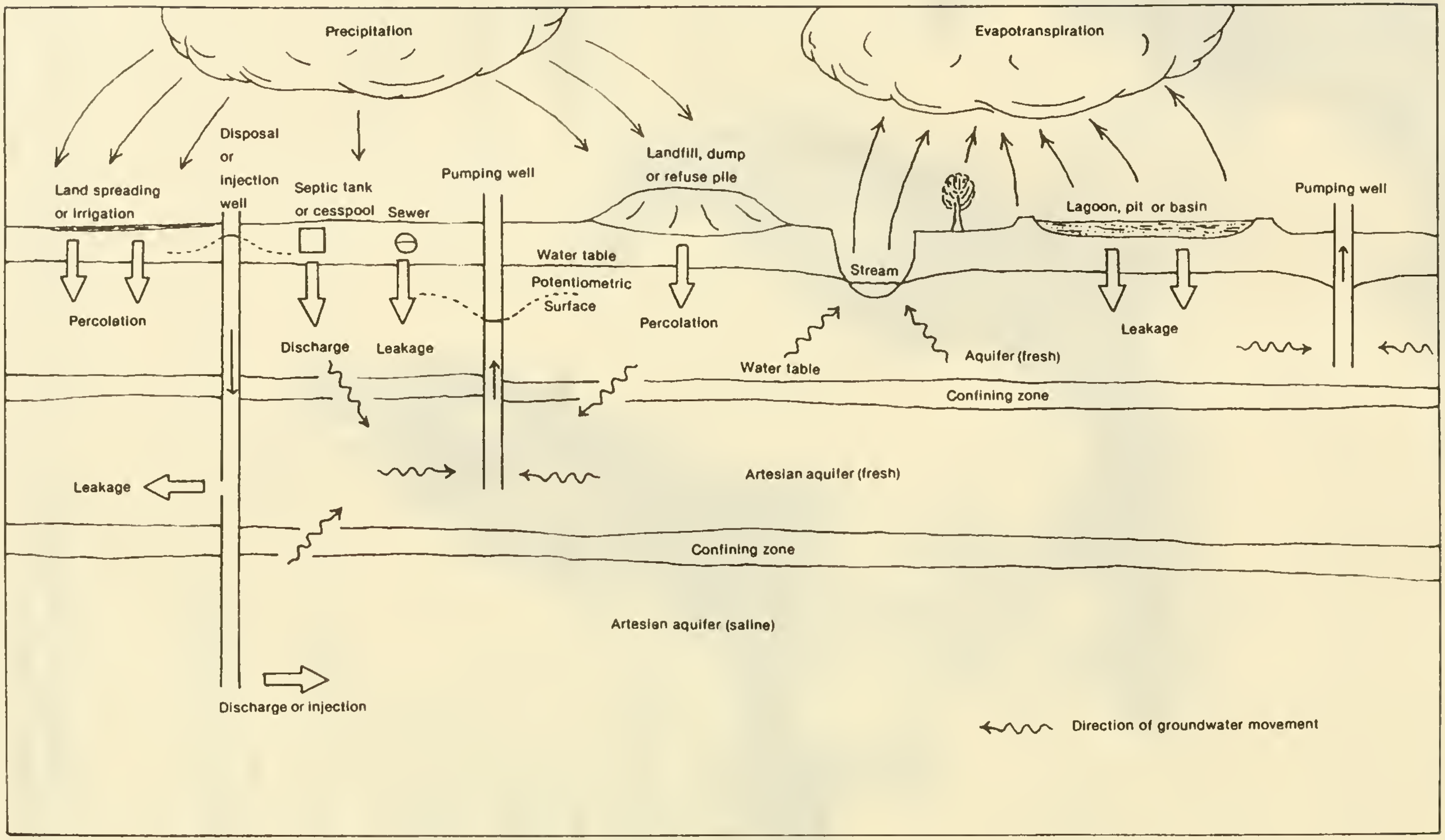

Figure 5. Contamination of the groundwater system by waste disposal practices (Environmental Protection Agency 1977).

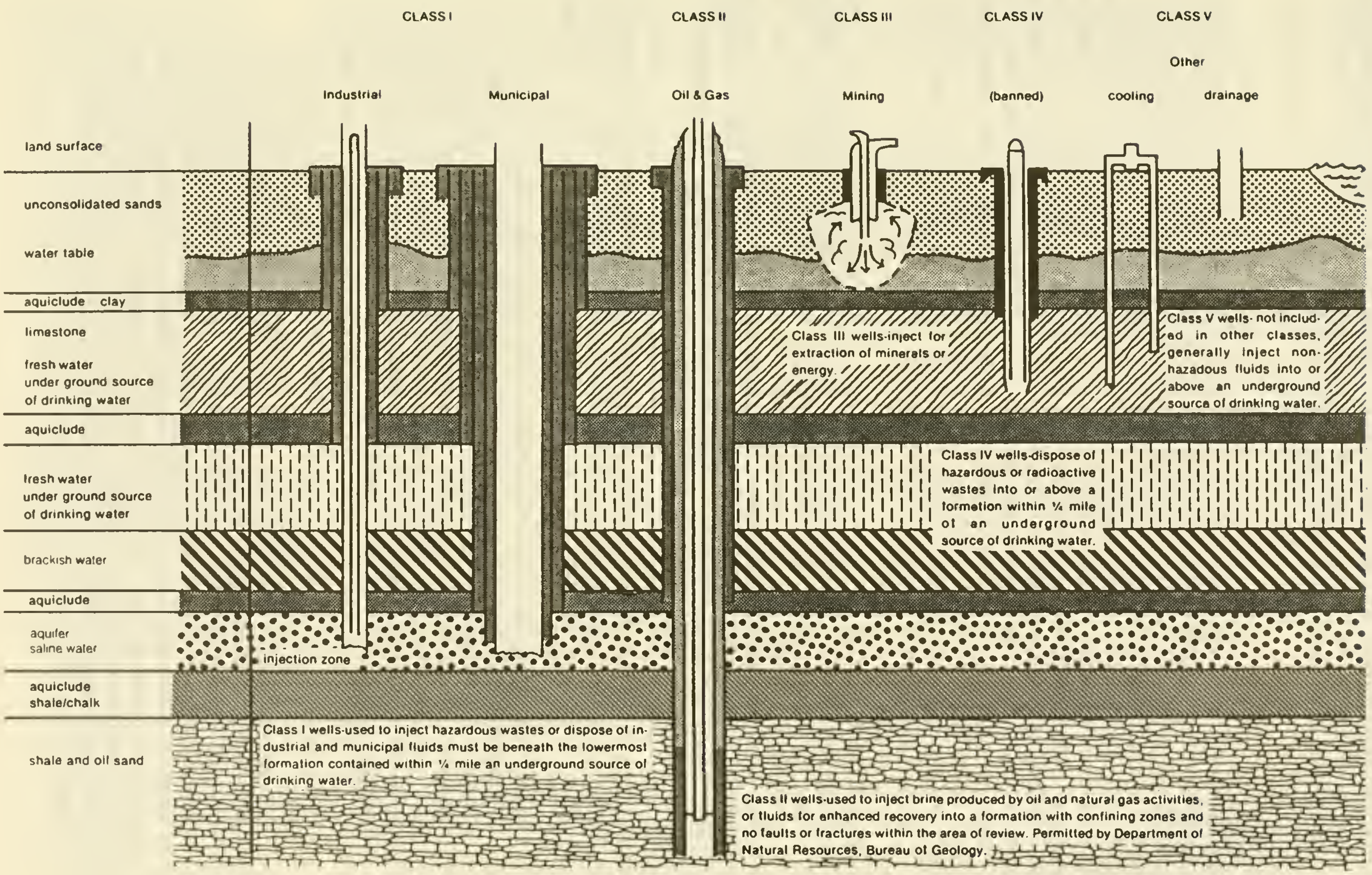

Figure 6. Underground injection control program classification of wells (Florida Department of Environmental Regulation 1981d).

Class II and Class III wells are permitted by the Florida State Department of Natural Resources, Bureau of Geology. The other classes are permitted through the Florida State Department of Environmental Regulation, the most important of which are industrial and municipal wells.

Groundwater

Probably the single most serious environmental constraint to urban growth and other economic developments in Southwest Florida is the distribution and the availability of potable and nonpotable sources of water. Southwest Florida once was rich in surface and groundwater supplies that were adequate for domestic, industrial, and agricultural uses. Now rapid growth of the urban population of the coastal counties has led to severe shortages of potable drinking water and considerable competition for existing sources of any kind of water. Water tables and shallow aquifers have been substantially lowered by drainage improvements and by construction of canals for draining interior wetlands for agricultural and for industrial phosphate mining. The cumulative results of these canals have resulted in falling water tables and saltwater intrusion in many of the coastal areas of Southwest Florida (Florida State Department of Environmental Regulation 1979a).

The competition for water for public, agricultural, industrial, and commercial consumption is a growing problem that is especially acute during droughts. The counties that use the most water are Pinellas County, which currently withdraws 88 Mgal/d of groundwater of which 65.9 Mgal/d are for public supply, and Hillsborough County, which uses about 39 Mgal/d for public supply. Commercial consumption in Hillsborough and Pinellas Counties is about 23.0 and 15.9 Mgal/d, respectively. Industrial consumption is greatest in Hillsborough and Manatee Counties (8 Mgal/d in each).

A report entitled "A Regional Fiscal Impact Model: Applications for the Charlotte Harbor Region" prepared by Milliman et al. (1981) of the University of Florida describes the nature of the groundwater controversy as follows:

> Resulting stresses on groundwater sources have resulted in seriously overburdening groundwater supplies within the Charlotte Harbor area. In addition to these problems, contamination of shallow aquifers by uncapped abandoned wells drilled into highly salty artesian formations and pollution from septic tanks has seriously reduced their potential to supply freshwater needs.
>
> The deep Floridian aquifer underlies most of the area, but is high in chlorides, sulfates, and total dissolved solids and is not suitable for domestic use without extensive desalinization. Already many areas in this region are turning to reverse osmosis and electrodialysis processes to produce potable water from brackish groundwater sources. Desalinization is only cost effective in areas where a large scale system to develop and transport surface and/or groundwater has not been implemented. Expansion of desalinization plants in the Charlotte Harbor area is foreseen until more economical regional systems are constructed.

Competition for available water supplies will continue into the future and will likely be one of the most pressing environmental issues in Southwest Florida (Milliman et al. 1981).

Impoundments as a Source of Groundwater Pollution

One of the most pressing problems concerning the quantity and quality of surface water in Southwest Florida is the impoundment of freshwater streams to supply water for industrial and mining purposes, for municipal sewage treatment, and irrigation. Waste waters contaminated with bacteria and toxic materials often are released by users into the impoundments. Not only are the impoundments contaminated, but according to a Department of Environmental Regulation study in 1980, some of the water retained temporarily in the impoundments seep into shallow underground aquifers and contaminate public supply water there. Nearly all the drinking water used in Southwest Florida comes from these aquifers (the larger are called subsurface impoundments) and, without proper treatment, are a threat to public health.

Major aquifers in Southwest Florida that are affected are the Floridian aquifer, the shallow caustic acquifer, the sand ridge water table aquifer, and the Bay of Biscayne aquifer. Evidence is that these aquifers will be further threatened as the demand for clean water and wastewater disposal accelerate into a major conflict. Unless aggressive State action is taken, the quality of the water supply will degrade unchecked.

Insufficient treatment of waste waters discharged into surface impoundments will increase the cost of drinking water treatment. Continued degradation of the groundwater quality may eventually limit economic growth in the area. The 1980 report recommends steps that can be taken to minimize this threat. Currently the Department of Environmental Regulation is developing a series of groundwater and permit standards to protect shallow freshwater drinking water supplies from pollution.

Southwest Florida has a relatively large number of small impoundments. Hillsborough County has the largest number of mining related impoundments which are primarily holding areas for phosphate slime operations. It also has the largest number (224) of municipal impoundments, agricultural impoundments (82), and industrial impoundments (72). Lee County has a large number (238) of municipal impoundments, as do Sarasota, Manatee, and Collier Counties. Lee County has 66 industrial impoundments and 2 agricultural impoundments, and Pinellas County has 62 industrial impoundments. The risks involved with these impoundments were described earlier in the hazardous waste section of this report.

The Florida State Department of Environmental Regulation (1980b) completed a study in January 1980 that reported that "surface impoundments discharge pollutants into shallow aquifiers." These pollutants travel undetected through the subsurface. This study (referred to as a Surface Impoundment Assessment) reported thousands of subsurface impoundments that have the same potential as surface impoundments for contaminating groundwater supplies. The study further reported that more intense conflicts between clean water and waste water disposal will develop unchecked unless aggressive State action is taken. The current rate of degradation of drinking water supplies from groundwater pollution is likely to continue.

OTHER ENVIRONMENTAL ISSUES

Over the past few decades, extensive areas of Southwest Florida's interior wetlands and uplands have been dredged and drained and extensive diking has led to a major alteration of Southwest Florida's coastal wetlands. Coastal ecological alterations have caused changes in habitat composition, reduced the abundance of detritus and other sources of nutrients, decreased dissolved oxygen concentrations, excessively increased coliform counts, destroyed fresh-and saltwater marshes, and reduced natural purification of urban and suburban runoff. Natural eroding processes such as beach and river erosion and man-induced destruction of natural vegetation and habitat have caused further stress on fish and wildlife species (Florida State Department of Environmental Regulation 1979a).

This section identifies major manmade and natural environmental issues that are not necessarily pollution oriented. Because of its long coastline, tidal action, and extensive river networks and high flows, the hydrology of Southwest Florida is highly dynamic. Thousands of acres of marine grassbeds and mangrove communities are found throughout the estuaries, rivers, and tidal creeks. The status of environmental conditions in Southwest Florida as described by Milliman and Sipe (1979) are given below.

> The Charlotte Harbor area, including Lemon Bay, Charlotte Harbor, Piyone Sound, Matoachua Pass, San Carlo Bay, and Estero Bay, is the largest estuarine system in Florida and one of the most productive. Continued maintenance of natural salinity levels is vital to this productivity. The quality of water in the bays and estuaries is threatened by development in the area. Urban and agricultural storm runoff, sewage effluent and septic tank seepage provide fertilizer for algae growth and result in oxygen depletion. Additionally, coliform bacteria unacceptable to commercial shellfish harvesting has resulted from septic tank pollution. Mangrove forests cover thousands of acres around the bays and lagoons. They provide habitat for wildlife, buffers from hurricane storms and in recent years dredge and fill operations have destroyed large areas of mangrove forests. Also, urban and agricultural development have changed drainage characteristics of upland flows and freshwater into the mangroves and thus increase the amount and level of runoff concentrations. Thus salinity balances are disturbed and more nutrients are washed into the bay without natural filtration by the mangroves. Development that interferes with mangroves thus can affect the water quality, reduce hurricane protection, and threaten production of fish and wildlife.

Eight major environmental issues have been identified by the Southwest Florida Regional Planning Council's report on growth management of southwest Florida (1979). The most pressing issue is the competition for land and water necessary to meet the multiple demands of a rapidly growing population. Southwest Florida is confronted with potentially unserviceable and environmentally unsuitable residential locations that would serve better as marshes. About 94% of the undeveloped lots platted in Charlotte, Lee, and Sarasota

Counties are open to residential development. Without proper site selection and planning, flooding may be a threat and local water sources would be adversely affected. It is evident that ill-advised land use is not as likely under the current planning and regulatory standards as it has been in the past (Milliman et al. 1981). Large subdivisions often were created for volume sale without considering the environmental sensitivities of the area or the infrastructure support systems required for new population centers. A conservative assumption of 2.2 persons per potential dwelling unit in the platted areas of Southwest Florida would increase the population by 1.4 million people, whereas the actual forecast for 2020 is only 436,000 persons. In either event, the destruction of natural systems and further draining of wetlands for agricultural and phosphate mining purposes is certain.

LAND CLASSIFICATION ANALYSIS

In Pasco, Pinellas, Hillsborough, and Manatee Counties, 107,302 acres of Class II waters and 29,439 acres of marine grassbeds have been identified (Florida State Department of Environmental Regulation 1978). The area of brackish coastal marshes has been estimated at 7,238 acres and coastal mangroves at about 10,751 acres. The area of freshwater swamps and marshes was estimated at 24,500 acres. The report further identifies as areas of conflict over 189,500 acres that are presently developed, but only 3,334 acres of land are suitable for intensive development without corrective measures or protection from flooding. The total area that is developed covers more than 419,916 acres.

The Southwest Florida coastal area, which includes Sarasota, DeSoto, Charlotte, Lee, and Collier Counties has 198,137 acres of Class II waters, 57,190 acres of marine grassbeds, 69,000 acres of coastal marshes, 133,727 acres of coastal mangroves, and 16,869 acres of freshwater swamp and marshes. Over 213,811 acres are now developed but subject to conflict. Only 2,892 acres suitable for development without corrections or flood control remain undeveloped. Over 199,231 acres were designated as prime agricultural lands with other potential suitabilities. Total development in this four county area was estimated to be 493,990 acres.

The Florida State Department of Environmental Regulation study (1978) indicated that Monroe County has 152,268 acres of Class II waters, 426,848 acres of marine grassbeds, 159,539 acres of coastal marshes, 221,964 acres of coastal mangroves and about 65,000 acres of freshwater marshes. All of the developed land (22,675 acres) was subject to conflict. No undeveloped land suitable for development remains.

Extensive areas of suburban development have been platted in Southwest Florida. The greatest conflict is in the Charlotte Harbor area. Extensive areas of Class II waters, marine grassbeds, coastal marshes, and mangrove swamps still exist, but they are a fraction of what existed only a few years ago. If trends are not reversed in the future, continued growth and expansion into sensitive coastal wetlands will further deplete these valuable resources, and may lead to large scale destruction of other dependent environmental resources such as fisheries and beach recreation.

In Southwest Florida, especially southwest of Charlotte, an extensive and very fragile system of barrier islands extends along large stretches of the coastline. This chain of Barrier Islands extend from the Minnesota Peninsula on the north and includes the islands of Don Pedro, Gasparilla, Teocosta, Captiva, Sanibel, Estero, and Bonita Beach (Discussion with Staff, Bureau of Coastal Zone Management, September 1981). These islands protect the estuaries and coastline by buffering the forces of high tides and storms during inclement weather. They are dynamic and frequently shift and change with the tides and time. The littoral drift of sand and beach erosion on these islands makes their shores subject to radical change within relatively short periods of time. Their attractiveness for residential development and coastal recreation has invited further environmental threat. Inappropriate development such as artificial jetties, seawalls, groins, dredging, and filling activities interferes with natural forces and has created environmental stresses that disrupt and sometimes destroy these systems. An example of a positive measure that can be enacted to protect barrier islands is the comprehensive plan developed for the Sanibel and Captiva Islands just off the Charlotte Harbor area.

THE FLORIDA KEYS

The Florida Keys historically has been confronted with shortages of potable supplies of freshwater. Intensive development throughout the Keys has further worsened the shortage. Some natural systems are jeopardized by intensive development along the Florida Keys, such as the fragile and unique reef system that has undergone extensive alteration over the past few decades. The entire Keys chain is classified as an Area of Critical State Concern.

The major classification of land uses and wetland categories that are important for identification and protection throughout Florida was recommended by the Florida State Department of Environmental Regulation (1978).

FORECASTS AND TRENDS

Southwest Florida has been the focus of extensive research and investigation because increased urban growth has caused numerous social and environmental problems. One of the products of the State and regional research was an econometric regional forecast model (Milliman et al. 1981). The model has wide application for forecasting fiscal trends. It is designed to estimate changing fiscal circumstances as a result of changing socioeconomic and environmental conditions.

Another indicator of Southwest Florida's residential growth is the list of Development of Regional Impact (DRI) that is available from the Department of Community Affairs. The DRI's include certain classes of recreational, commercial, residential, and transportation developments. Extensive development has been permitted through the DRI procedure and is likely to continue throughout Southwest Florida. Residential development is most likely for Lee, Sarasota, Manatee, and Monroe Counties and greater industrial developments, frequently related to phosphate mining, can be expected in Manatee, Sarasota, and Hillsborough Counties.

The critical habitat for some of Florida's endangered and threatened species (mammals, birds, reptiles, amphibians, and plants) in Southwest Florida are listed in Figure 7. As their habitat continues to disappear, so also do their numbers. A further description of habitat destruction is given elsewhere in this report.

PUBLIC OWNERSHIP AND MANAGEMENT OF LAND

Extensive tracts of land in Southwest Florida are owned by Federal, State, and local governments, and are used for a variety of purposes. The vast holdings of the Federal Government include the Everglades National Park and the Big Cypress National Preserve that encompass large tracts of land in Monroe and Collier Counties, with the Faxahatchee Strand, Cayo Costa North Captiva Islands, and Weeden Island in Pinellas County. There are other smaller State, Federal, and local holdings throughout the region. The purchase of even more fresh and saltwater swamps in Southwest Florida by Government agencies are attempts to retain the quality of the remaining wetlands for water retention, conservation, groundwater recharge, and flood control.

The State's Environmentally Endangered Lands program provides an important source of funding for acquisition of biologically and hydrologically valuable lands in Southwest Florida (Figure 8). Other purchases are or will be made to expand the recreational opportunities and wildlife habitat to compliment other land uses.

Aquatic Preserves

Southwest Florida has an abundance of highly productive and well protected aquatic preserves managed by the Florida State Department of Natural Resources (Figure 9). Current legislation for aquatic preserves is undergoing modifications that will further upgrade their protection.

The administration of aquatic preserves by the Department of Natural Resources was established in the Florida Aquatic Preserve Act of 1975 (Ch. 258 Florida Statutues), and states in part that:

> It is a legislative intent that the state-owned submerged lands in the areas which have exceptional biological, aesthetic and scientific value, it is hereinafter described to be set aside forever as aquatic preserves or sanctuaries for the benefit of future generations.

Waste disposal, dredging, and filling are severely curtailed in aquatic preserves, as discussed in greater detail in a later section.

The State's major wildlife management areas are shown in Figure 10. The three in Southwest Florida are the Big Cypress, Cecil Webb, and Hillsborough Wildlife Management Areas. A list of Florida's State preserves, forests, and parks are given in Figure 11. A large number of these facilities are in Southwest Florida, including the Myakka State Park in Sarasota County, the Collier-Seminole Park in Collier County, and the John Pennekamp Coral Reef Park in Monroe County.

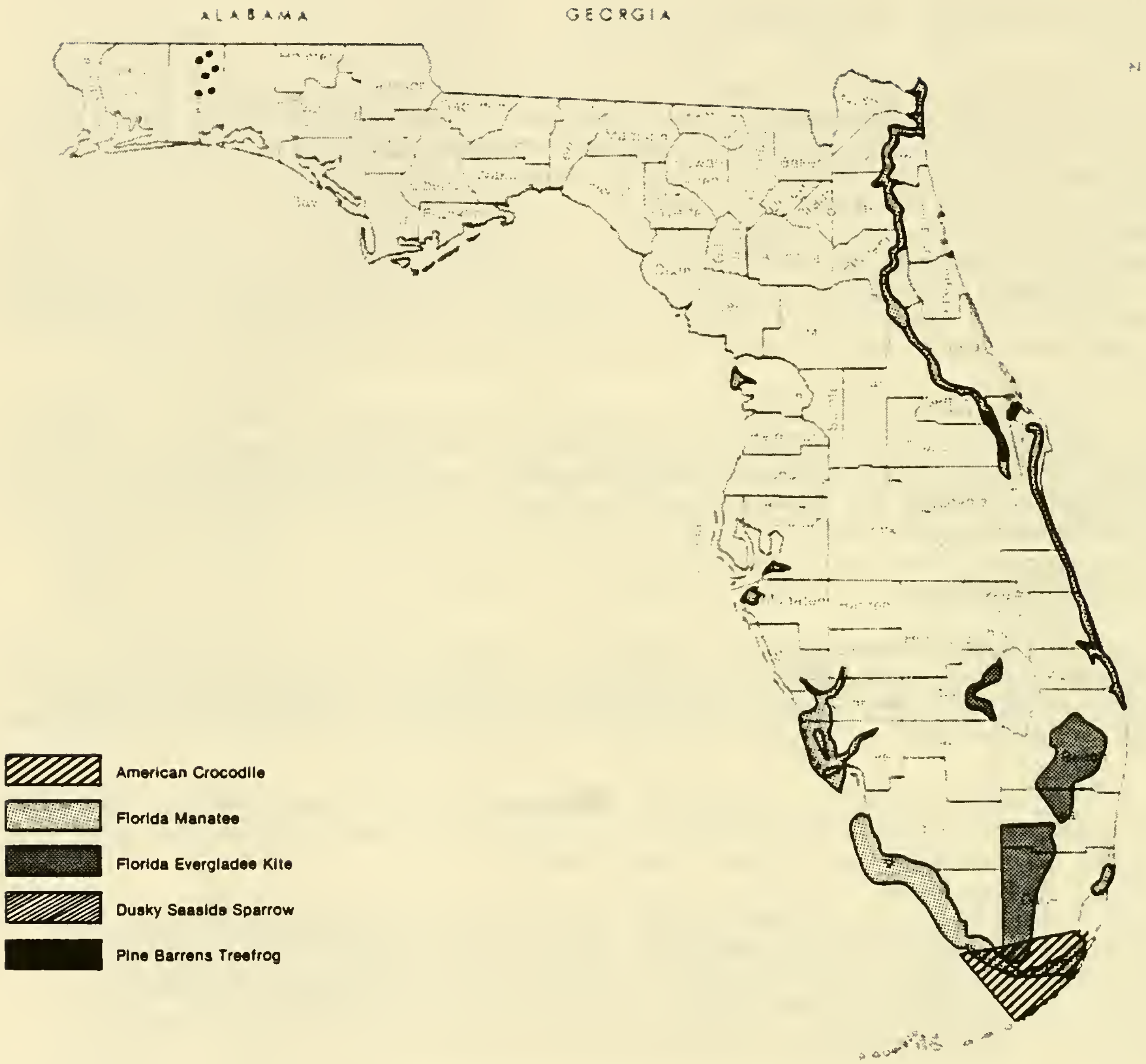

Figure 7. Critical habitats in Florida (Florida Power and Light Co. 1979).

Figure 8. Environmentally endangered lands (Florida Power and Light Co. 1979).

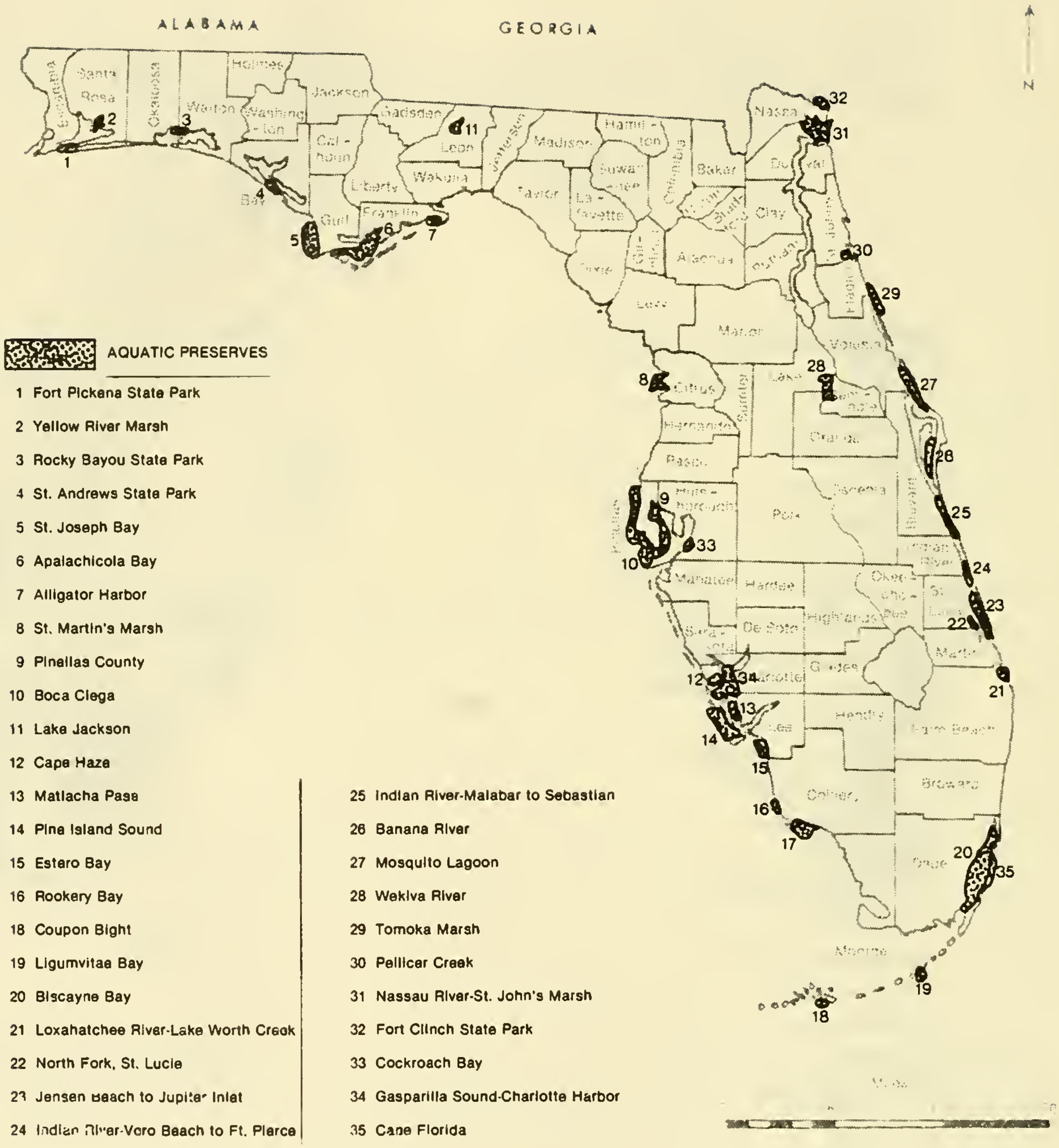

Figure 9. State aquatic preserves (Florida Power and Light Co. 1979).

Figure 10. State wildlife management areas (Florida Light and Power Co. 1979).

Figure 11. State preserves, forests, and parks (Florida Power and Light Co. 1979).

The State designated Areas of Critical State Concern are given in Figure 12. The two in Southwest Florida are the Big Cypress area in Collier and Monroe Counties and the Florida Keys in southern Monroe County.

Outstanding Florida Waters

The Florida State Department of Environmental Regulation, under its water quality designation authority, has set aside certain bodies of water and segments of other water bodies for special protection. Selected bodies of water are designated "Outstanding Florida Resource Waters" because of their unique ecological characteristics and value, and are protected to retain their essentially pristine state (Florida Administrative Code Ch. 17-3). No further degradation of these bodies of water is authorized. Southwest Florida has a large number of these classified water bodies. The complete list is available in Ch. 17-3, FAC.

ENVIRONMENTAL ACTS AND REGULATIONS

Throughout this report specific references have been made to existing State, Federal and local regulatory standards in appropriate natural resource categories. A discussion of the Federal and State water quality standards classification scheme was outlined under the water resource issues, and a similar examination of State and Federal standards was undertaken in the air quality segment of this report. These discussions, however, fail to provide a sufficient broad-based review of the existing Federal, State and local regulatory framework within which reviewers and users of this report can be guided. The following analysis is a brief review of major environmental acts and regulations.

FEDERAL

Federal Aid and Wildlife Federation Act, 1937

The purpose of this act is to inaugurate a program of Federal aid to the states for the restoration and management of wildlife. Through this Act, about $350 million have been allotted to state fish and game department wildlife restoration projects.

Fish and Wildlife Act of 1956

The purpose of this bill is to provide a framework in which the problems of the commercial fishing industry can be resolved, and give recognition to the importance of outdoor recreation. This Act established the United States Fish and Wildlife Service in the Department of Interior.

Fish Restoration and Management Projects Act

This act is designed to provide Federal aid to the states for restoration in the management of their fisheries resources, financed through a special fund from a tax on fishing rods, reels, bait, flies, and other fishing related expenditures.

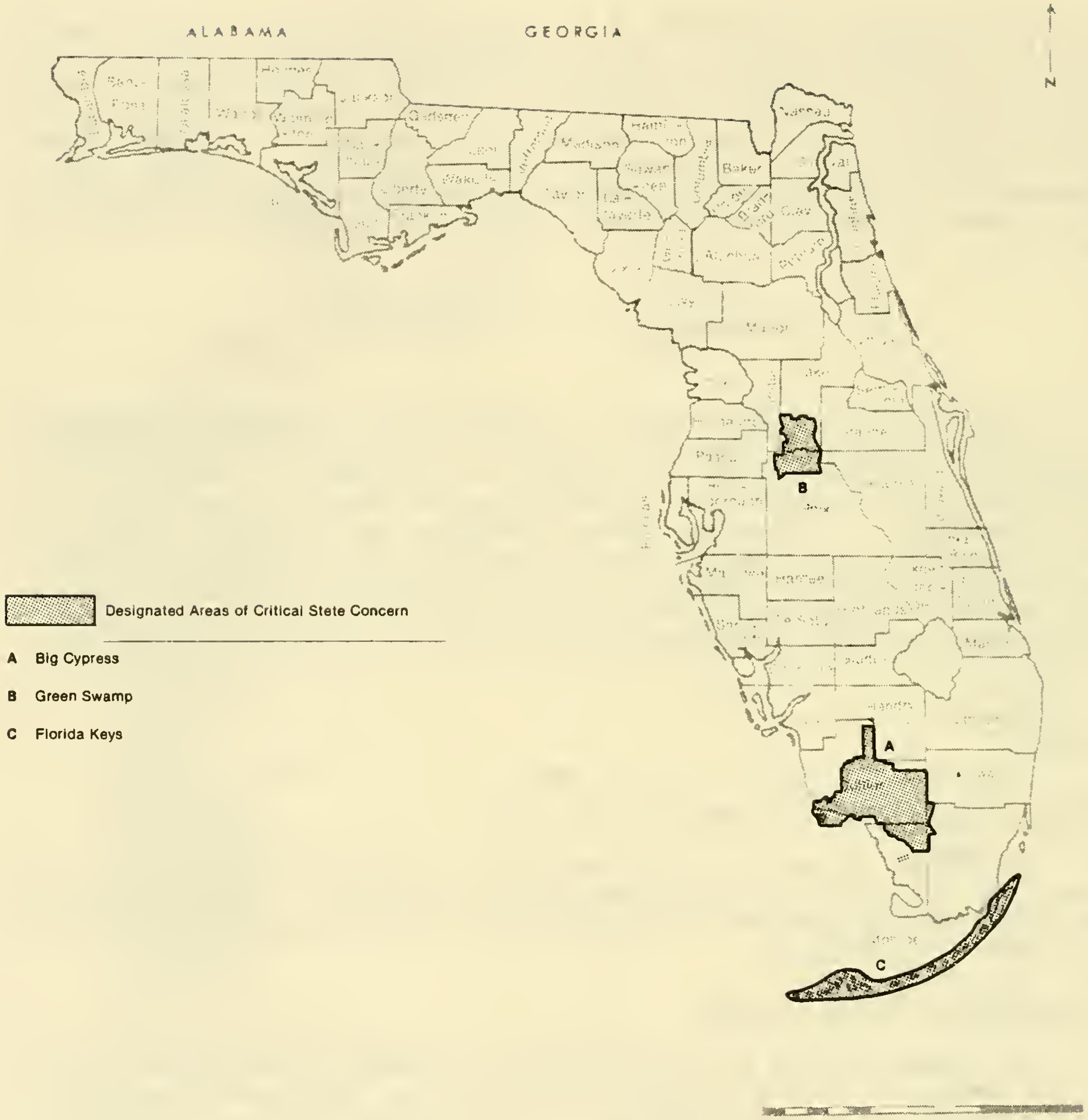

Figure 12. Areas of critical State concern (Florida Power and Light Co. 1979).

Estuary Protection Act P.L. 90-454

This act authorizes the Secretary of the Interior to conduct an inventory and study of the Nation's estuaries, working towards the goal of protecting, saving, and restoring them.

Marine Sanctuaries Act of 1972

This act authorizes the Secretary of Commerce, with the approval of the President, to designate as "Marine Sanctuaries" those areas of coastal waters, as far out as the outer edge of the continental shelf, or of coastal waters wherever the tide ebbs and flows, which he determined need Federal protection in order to maintain their ecological and recreational values. In 1979, this act was employed in southwest Florida for designation of the Apalachicola Marine Sanctuary.

Endangered Species Act of 1973

This act provides mechanisms through the Secretary of Commerce for protection of endangered species of fish and wildlife by way of direct Federal action and by encouraging states to establish conservation programs. Enforcement include civil and criminal penalties.

Federal Insecticide, Fungicide, and Rodenticide Act as ammended by the Federal and Environmental Pesticide Control of 1972, P.L. 92-516. The purpose of the original legislation was to control the composition of the pesticides through adequate labeling and instructions and tests on side effects, and for registering aquatic poisons. The amendment initiated a system to prevent indiscriminant application of pesticides to protect fish and wildlife.

Federal Water Pollution Control Act

The passage of this act was the Federal Government's first major intent to take an active role in the fight against water pollution. The original 1948 Act emphasized state control, but was limited in scope to interstate waters and tributaries.

Federal Water Pollution Control Act Amendments of 1972 P.L. 92-500. The 1972 Amendments completely revised and restructured the 1948 Act. The major goals of the act were to:

- Eliminate the discharge of pollutants into navigable waters by 1985, and maintain water quality suitable for fish and wildlife, and other forms of recreation by 1983.
- Prohibit the discharge of toxic pollutants.
- Provide financial assistance to construct publicly-owned waste treatment works.
- Develop and implement area-wide waste treatment.
- Develop the technology necessary to eliminate the discharge of pollutants into navigable waters.

To attain these goals, the emphasis of legislation has been changed from water quality standards to effluent limitations. The new approach uses effluent limitations as a basis to eliminate pollution by 1985. Water quality standards also are established in the new act. States such as Florida may set up their own water quality standards based on the Federal Class I through Class V classification system.

The 1972 amendments require that all publicly owned sewage treatment plants provide a minimum of secondary treatment by 1 July 1977 and advanced waste treatment by 1 July 1978. The amendments also require that industrial discharge should meet the best practical technology requirements by 1 July 1977 and the best available technology by 1 July 1983. EPA has extended the deadlines to 1 July 1983 for compliance with requirements for publicly owned sewage treatment works as described below:

Type pollutant	Level of technology	Legislative deadline
Conventional	Best conventional pollution control technology	1 July 1984
Toxic	Best available technology economically achievable	1 July 1984 for existing toxic pollutants; 1 to 3 years after determination of new toxic pollutants
Nonconventional	Best available technology economically achievable.	3 years after effluent limits are established but no later than 1 July 1984 and never later than 1 July 1987.

Ocean Dumping Act

This act forms congressional policy to regulate the dumping of all types of materials into those waters lying seaward of the base line from which the territorial sea is measured. The act is particularly concerned with the dumping of materials that would adversely affect human welfare and the marine environment.

Clean Air Act of 1963

The Clean Air Act revises existing air pollution laws in an attempt to strengthen basic authority as well as the role of the Department of Health and Human Services regarding air pollution.

Clean Air Act Amendments of 1970

This act is a reflection of the Federal Government's recognition of air quality as a national problem and its implicit acceptance of primary responsibility for air pollution control. These amendments provide for advanced air

pollution abatement timetables and significantly greater Federal involvement including increased civil penalties. It is also the first attempt to control auto emissions. The act further establishes procedures for EPA to promulgate national ambient air standards based solely on factors relating to public health and welfare without regard to technological and economic feasibilities.

In April 1971, EPA issued the first national contaminant standards for sulfur oxide, carbon monoxide, particulates, photochemical oxidents, hydrocarbons, and nitrogen oxides. National ambient air quality standards for lead have since been prepared. Primary standards are designed to protect public health and secondary standards are designed to enhance the environment.

EPA also has set standards of performance for certain stationary sources of pollution. Some of these emission standards apply to new and existing point sources, whereas others apply specifically to new sources. Some pollutants are so hazardous that the act requires direct Federal standards and enforcement to protect the public health. National emission standards have been set for asbestos, berylium, mercury, and vinyl chloride. Benzene has also been designated a hazardous air pollutant in June 1977.

Section 220 of the act calls for development by each state of a plan for the implementation, maintenance and enforcement of primary and secondary standards of air pollution. These plans, called State Implementation Plans, (SIP) must assure air quality consistent with the national standards.

Currently, amendments are being made to the Clean Air Act in Congress. The provisions for changes to the Clean Air Act as recommended by the National Commission on Air Quality were made to strengthen the existing Federal and state programs. Proposals to do away with the Prevention of Significant Degradation requirements and other administrative Federal mandates were submitted to Congress in the Spring of 1981.

Resource Recovery Act of 1970

This act was designed to provide Federal assistance to state and local governments to assure proper disposal of solid wastes.

The Resource Conservation and Recovery Act of 1976

This act sets out to broaden the national solid waste management program, and conserve natural resources through waste reduction, and minerals and energy recovery. EPA is authorized to:

- Regulate the disposal of all hazardous wastes.
- Establish state regulatory programs to close all open dumps and control all land disposal of solid wastes, including sludge.
- Encourage the development of basic national resource conservation and recovery policies.

Toxic Substances Control Act (P.L. 94-469)

The Toxic Substances Control Act authorizes EPA to obtain data from industry on selected chemical substances and mixtures and to regulate the substances when needed. Chemicals used exclusively in pesticides, food, food additives, drugs, nuclear materials, tobacco, firearms, and ammunition are exempt from this act.

National Environmental Policy Act of 1969

This act requires the preparation of a detailed environmental impact statement whenever there is a proposed major Federal action that would significantly affect the quality of the human environment. Environmental impact statements must be prepared prior to any major Federal activity in the coastal zone, including offshore energy development.

National Flood Insurance Act of 1968

This law provides limited indemnification to the victims of flood disasters through flood insurance to residents of flood-prone areas, provided that local jurisdictions require land-use control measures to guide safe use of flood zones.

Coastal Zone Management Act of 1972, and Amendments of 1975

The purpose of this act is to encourage the development of comprehensive state management programs and to formulate a national coastal zone policy for lands in the coastal zone area. It is implemented by the Office of Coastal Zone Management, National Oceanographic Atmospheric Administration, Department of Commerce, and provides assistance to coastal state governments for the development and implementation of coastal zone management plans. These plans are designed to assure the orderly and environmentally sound development of the coastal zone. Recent amendments to the act provide additional financial assistance to coastal states for new facilities and additional planning needed to offset coastal energy development. In Florida the Coastal Zone Management plan is in the final stages of development and approval.

Submerged Lands Act

This act is designed to promote the exploration and development of petroleum deposits by settling disputes between state and Federal governments over rights to ownership of submerged lands. Its importance is in terms of managing, leasing, and developing offshore energy. It serves as the basis for ownership disputes over state and Federal jurisdiction of the submerged lands of the continental shelf seaward from state boundaries. In the Gulf of Mexico, Florida and Texas state boundaries extend seaward approximately 9 mi; other state boundaries extend seaward only 3 mi. The Secretary of the Interior designated the Bureau of Land Management (BLM) as the administrative agency for leasing submerged Federal lands; the U.S. Fish and Wildlife Service (FWS) helps design environmental studies and acts in an advisory capacity through much of the leasing process.

STATE OF FLORIDA

The State of Florida, since the late 1960's, has been very active in promulgating and enforcing environmental legislation. This section will identify the major laws and briefly discuss the most significant environmental programs. A matrix of major environmental legislation and affected state agencies and activities related to permitting in the coastal zone is given in Figure 31, Part 2, Data Appendix. The most significant environmental laws enacted in Florida are reidentified and listed in this matrix, as are the major Federal and state agencies, in addition to a listing of the state legislative mandates used to manage activities and uses of water and land within the coastal zone. The most useful laws for environmentalists are given in the following sections.

Pollution-spill Protection and Control, Florida Statutes, Chapter 376-Section 376.021

This statute addresses the transfer of pollutants between vessels and/or between terminal facilities. The potential discharge into the environment of products being transferred poses a threat to the environment. These pollutants include many grades of oil, pesticides, ammonia, chlorine, and their derivatives. The statute requires a registration certificate for the operation of terminal facilities and gives authority to inspect the facilities to determine if they comply with regulations.

This statute establishes the mechanism to help in clean-up and rehabilitation of the environment after a pollutant has been discharged. The Florida Coastal Protection Trust Fund states that any owner or operator causing the pollution shall be liable for all clean-ups and abatement costs. An excise tax of 2 cents per barrel of the pollutants (mostly oil) has been assessed by the State of Florida to clean-up chemical spills.

Energy Resources Part II, Regulation of Oil and Gas, Florida Statute 377 Section 377.242. This legislation states that no drilling permit shall be granted within one mile inland from the coastline unless sufficient environmental protection provisions have been taken to protect the state's estuaries, beaches, and shorelines. Issuance or renewal of the permit requires a valid deed, or lease, granting the rights to oil and gas exploration, and satisfactory evidence that the applicants will clean-up any for which they are responsible. The Department of Natural Resources has the responsibility for the rules' administration.

Environmental Land and Water Management Act, Florida Statute 380

The purpose of this act is to develop management strategies and policies to protect natural resources, the environment, and the water quality of the State. This is accomplished through designation of "Areas of Critical State Concern" by the Administration Commission if the areas are deemed to have significant environmental, historical, or archaeological resources of statewide importance. The three currently designated critical areas are the Green Swamp, the Big Cypress Swamp and the Florida Keys.

The second component of this statute defines the Development of Regional Impacts (DRI). A DRI is any development that because of its character, magnitude or location, would have a substantial effect on the health, safety, or

welfare of citizens of more than one county. A number of DRI's have dealt with large-scale residential, commercial, and transportation related activities, and have required high levels of review and scrutiny from Regional Planning Councils and the Department of Community Affairs. DRI permits, which may include energy facilities, industrial plants, mining operations, petroleum storage facilities, or port facilities, involves integrated State and local review of environmental and socioeconomic factors.

Beaches and Shores Prevention Act, Florida Statue 151 (1975)

This act provides for a 50-ft construction setback line from the mean highwater line to be established on a county-by-county basis throughout the coastal areas of Florida and prohibits construction seaward of that line without a waiver or a variance. The statute requires permits for any coastal construction or reconstruction. The Division of Marine Resources enforces and coordinates provisions of this law.

Florida Statute 403.11 and 403.4152 (1975)

Legislation in Part I of Chapter 402 declares that the pollution of air and water in the State constitutes a menace to public health and welfare and is harmful to fish and othe aquatic life and detrimental to domestic, agricultural, industrial, recreational, and other beneficial uses of air and water. The public policy of the State is to conserve the air and waters of the State and to protect the propagation of wildlife, fish, and other aquatic life.

Statute 403.062 states that the department has general control and supervision of underground waters, lakes, rivers, streams, canals, ditches, and coastal waters inasmuch as their pollution may affect public health or interests. Section 403.088 states that permits are required for stationary installations that are expected to be sources of air or water pollution. The discharge of any waste into the waters of the State is prohibited without authorization, and water quality standards will be enforced. Section 403.061 grants to the DNR the authority to enforce these provisions, and Section 403.085 states that permits are required for ocean outfalls. Secondary treatment or other treatment may be required as necessary before the permit will be granted.

State Parks and Preserves, Florida Statute 258

The three main developments in this statute are as follows:

- o Miscellaneous parks and preserves created (258.08-.165). This section establishes six separate parks and preserves around the State and provides for their maintenance and administration. The aquatic preserves of Boca Chega and Biscayne Bay are created. Further development of bottomlands through dredge and fill is prohibited.

- o State Wilderness System Act of 1970 (258.17-.33). The general intent of this act is to establish a permanent system of wildlife preserves.

- o Florida's Aquatic Preserve Act of 1975 (258.53-.46). This act is intended to preserve forever state-owned submerged lands in areas

that have exceptional biological, aesthetic or scientific value. In these areas, no further alienation by the State by dredging and filling, bulkheading, mining or development will be permitted except for specific exceptions. Section 258.3(c) prohibits drilling for gas or oil within a preserve but permits drilling from outside the preserved area. The DNR administers the Aquatic Preserves, State Wilderness Areas, and State Parks and the Governor and Cabinet, sitting as the board of Trustees of the Internal Improvement Trust Fund, have final approval regarding these facilities and areas.

Game and Freshwater Fish, Florida Statutes 372

This law prohibits contamination of fresh waters of such magnitude that it will damage freshwater aquatic life. This law is enforced by the Game and Freshwater Fish Commission.

Water Resources Act 1972: Part I, the State Water Resource Plan, Florida Statutes 373.013

The Florida Resources Act of 1972 covers all State waters unless exempt, and provides for the comprehensive management of water and related land use including development of dams, impoundments, reservoirs, and other works to provide water storage and to prevent damage from flooding, soil erosion, and excessive run off. Section 373.026 designates the responsibility to the DER for the broad powers and authorities under the Act, and supervision of the Water Management District.

Water Resource Management Act 1972: Part II-Permitting of Consumptive Use of Water, Florida Statute 373.203-.249

Section 373.219 requires a permit for the consumptive use of water and imposes reasonable conditions to assure that the permitted use is consistent with the overall objectives of the water district of the DER and not harmful to the water resource of the area. The use to which water is put must be a reasonably beneficial one; reasonable from the stand-point of other landowners and the public. The water management districts are authorized by the DER to be responsible for issuing consumptive use permits.

Local and Intergovernmental Programs, Florida Statute 163-.3191

This legislation enables counties and incorporated municipalities to plan for future development and to prepare, adopt, and amend comprehensive plans to guide future development. These comprehensive plans should include zoning and subdivision regulations, policies for land and water use, and building and electrical, gas, and sanitary codes. A coastal protection element shall be included for those units of local government lying in part or in whole in the coastal zone.

Local governments use their authority in relation to the environmental problems of OCS development in several ways. Land is administered to ensure environmental protection, and local governments have the authority to administer land- and water-use regulations. Local governments have the power of eminent domain, which can be used as an enforcement mechanism to ensure compliance with sewage and landscaping requirements, and environmental

requirements, and to acquire land for necessary facilities. A local infrastructure already exists in some areas to regulate air and water pollution.

Each coastal community within the region has a coastal component of its comprehensive land-use plan either developed or in the development phases, such as the land-use provisions of the Sanibel Island Comprehensive Plan, Chapter 5 entitled, "Conservation/Coastal Zone Protection." To protect these basic resources, the objectives, policies, and implementation of the recommendations of Franklin County's Comprehensive Plan are predicated upon the following goal:

> To guide development in such a manner that the basic functions and productivity of the County's natural land and water systems will be conserved over time, and to reduce or avoid health, safety, and economic problems for the present and future residents of Franklin County.

This element provides a set of objectives and policies designed for the comprehensive plan to accomplish its goal.

Local government's jurisdictional authority can either hinder or aid OCS and other energy-related facilities within its jurisdiction. Local governments can take land through eminent domain for development of public industrial parks, port facilities, utilities, or road easements. The same local governments can promulgate regulations on air, water, solids, and hazardous wastes that are more stringent than Federal or State regulations. They can request aid in funding certain activities that support OCS oil and gas related activities and may even be able to co-author municipal bonds for development of infrastructures and facilities essential for on and offsite support for OCS oil and gas production needs.

<u>Chapter 253, F.S. enacted through Section 17-4.29, FAC</u>

The jurisdictional authority of Chapter 253 is restricted to navigational waters (natural or artificial), mean high water line for waters subject to tidal action, and ordinary high water line on nontidal lakes. Focus is on fish and wildlife habitats, navigation impacts (potential obstructions to navigable waters), riparian rights, and water flow. If the proposed activity is within an aquatic preserve, the additional requirements of Chapter 258, the Aquatic Preserve Act, are considered in permitting decisions. It is the Department's policy that any dredge and fill project over 10,000 yd^3 is processed by the central office of the DER in Tallahassee, Florida.

<u>Water Quality Based Discharge Permits</u>

<u>Chapter 403.087, and .088, F.S. implemented through Chapter 17-4.03, FAC</u>
The provisions of these statutes direct the department to issue technology-based standards (such as 90% treatment required for sewage treatment facilities within the State), and effluent-based water quality wasteload allocations that limit the discharge for a particular facility up to the point of ambient water quality standards.

Air Quality Permitting Activities, Legislative Authority Chapter 403.087

Implemented through the provisions of Chapter 17-2, FAC. Emission levels are set through technology-based standards and ambient-based standards depending upon the nature of the source seeking the permit. The authority for all air quality permitting activities is enacted through Chapter 17-2, FAC. These restrictions include those for nonattainment areas, technology standards such as new source performance standards and best available control technology, and other State Implementation Plan authorities such as Best Available Control Technology determination and prevention of significant degradation.

DATA GAPS

One of the major problems in any environmental assessment is the lack of adequate and standarized information. Monitoring air, surface, and ground water conditions is designed to identify existing or potential problems. Monitoring of point sources pollution gives only a single view that is distorted if generalized to a broader area or time frame. Conversely, poorly placed monitors easily miss major environmental degradation and rate the quality too high. The complexity of interacting forces and a lack of useful measurement techniques may lead to bias in the final data.

Because of the lack of funding, monitoring equipment is frequently not placed in non-problem areas. In many areas of the State meaningful baseline air quality data are lacking. For example, air and water monitoring stations are located outside of major urban or industrial sites. Florida's ground water aquifer system has not been adequately monitored and the extent of potential risk from hazardous waste sites is not well understood.

Summary of Federal and State Dredge and Fill
and Discharge Permit Requirements

The DER and the Army Corps of Engineers (COE) have a joint permitting agreement that authorizes an applicant to submit one basic application to both agencies for dredge and fill proposals. This joint application will be separately reviewed by the DER and COE to determine which agency has jurisdiction. The COE typically has broader authority in the headwaters of navigable streams. The general authority for COE is issuance of dredge and fill permits for discharge of clean fill into navigable waters and supporting the Clean Water Act (Section 404), the Rivers and Harbors Act of 1899, and the Marine Protection Research and Sanctuary Act of 1972. The EPA additionally has the authority for issuing effluent permits under the provisions of the Clean Water Act and the Clean Air Act.

Florida Permitting Provisions establish the authority to administer and enact rules as set forth in State statute. (Legislative authorization for the DER's permitting activities are in Chapter 253, F.S. and Chapter 403 F.S.) The DER may issue and deny permits and define and refine those areas of established legislative authority consistent with the Florida Legislature. The rules established by DER set forth the implementation of the intent delegated through the statutes.

Within DER the two basic dredge and fill permit authorities are covered by Chapter 403, F.S., implemented through Chapter 17-4.28. This authority extends to certain listed waters of the State and to the landward extent to natural and artificial water bodies connected to the designated, listed water body. The definition of landward extent is established by the vegetative index in Section 17-4.02(17). The permitting jurisdiction under Section 403 focuses on short and long pollution problems judged in light of water quality parameters.

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ENERGETICS MODELS OF SOCIOECONOMIC SYSTEMS

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INTRODUCTION

This synthesis paper discusses the use of energetics models as a tool for studying socioeconomic and environmental systems. It provides a method for integrating the processes and components of natural and socioeconomic production. This paper also introduces the theoretical principles of energetics modeling and its limitations, followed by a discussion of the general methodology used in the design and execution of an energetics model. The results of an energetics model of Tampa and Hillsborough County in southwestern Florida are discussed, along with several other models, to show the types of research questions that can be answered using this method.

Different approaches have been proposed and tested for modeling natural and human systems. This paper focuses on the use of energy as a common denominator for all flows and storages within the systems under study. Energy circuit models are evaluated by measuring the quantity of energy flowing in a particular pathway or stored in the system. Because all activities, interactions, and even storages require energy, and in fact are energy, it is possible and practical to quantify a particular pathway by its energy value.

MODELING LANGUAGE AND SYMBOLS

The symbols used in the systems diagrams were established by Howard T. Odum (1971) and are part of the energy circuit language. The language combines several approaches that show energetics and provide insight into the mathematical description of a system, and illustrates a holistic approach. Energy circuit language contains a hierarchy of symbols that allow the diagramming of several levels of complexity in one model.

Several of the more commonly used energetics language symbols are illustrated in Figure 1. The water-tank-shaped symbol (A) represents an energy storage. The lines intersecting the storage symbolize energy flow pathways with flow in the direction of the arrows. The circle (B) is the symbol for an energy source which supplies power to the model from outside the systems boundary. The heat sink (C) is used to illustrate how waste heat or degraded energy is removed from the system.

The next three symbols (D, E, F) are group or subsystem symbols. These symbols are used primarily to aid in model organization. The hexagonal symbol (D) represents a self-maintaining consumer subsystem. A cow or city is an example of a consumer system. Consumers require concentrated energy from producers to operate, and feedback some energy to control the producer system. The bullet-shaped symbol (E) represents a producer subsystem. Producers are capable of upgrading dilute forms of natural energy such as sun, wind, and rain into more concentrated forms of energy such as plant biomass. The use of carbon from the atmosphere and nutrients from the soil by plants in the photosynthetic process is an example of a producer system. Producer and consumer systems are coupled to process energy and cycle matter within energetics models of systems of man and nature. The third group symbol (F) represents a logic action. The logic symbol is used to diagram a process in which the outcome has an off-on effect such as an electron.

The transformation process is represented by G. Relative dilute energy interacts with concentrated energy in the process symbol to produce some intermediate product. This symbol is commonly called a production function. An example would be the interaction of a plant with natural energy to produce plant sugar or the interaction of materials, fuels, capital, and labor in a city to produce a product. The energy and money transaction is represented by H. The solid line represents the energy flow and the dashed line represents the flow of money. The small circle is used to label the price (ratio of money to energy). This symbol is often used at the system boundary to control imports based on money stored in the system and collect money from exported products. The last symbol (I) is a flow sensor which is used to monitor flows of energy.

PRINCIPLES OF ENERGETICS MODELING

All energetics models, when designed properly, are consistent with the first and second laws of thermodynamics. The first law of thermodynamics states that energy is neither created nor destroyed; all systems of man and nature conserve energy. This principle of conservation of energy is incorporated into energetics models by requiring that the sum of all flows into a system, minus the energy flowing out, equal the net changes in energy storages within the system or any part of the system. In developing an energetics model that is consistent with the first law requirements, it is important that all energy flows be measured in their heat equivalent value.

The second law of thermodynamics pertains to the degradation of energy. This principle states that in all useful processes some energy must be degraded and thus lose its ability to do further work. Energetics models incorporate the second law by requiring heat sinks, or energy degradation flows, on all energy interaction and energy storages.

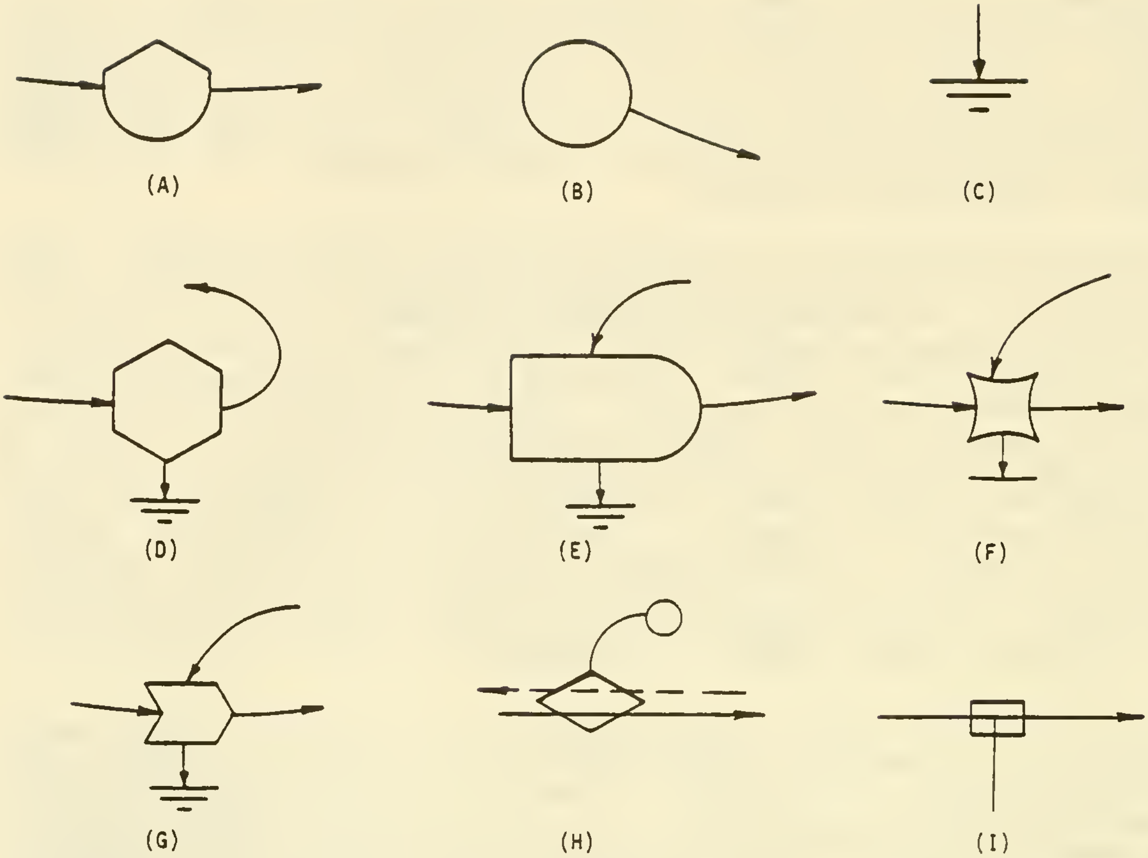


Figure 1. Energy circuit diagramming symbols: (A) energy storage; (B) energy source; (C) heat sink; (D) self-maintaining consumer unit; (E) self-maintaining production unit; (F) logic unit; (G) transformation or production function; (H) money energy transaction and (I) energy flow sensor.

The maximum power principle states that systems which take advantage of the maximum number of energy sources and use them most efficiently have the best chance of survival and are more competitive than systems which cannot sufficiently use the energy sources available (Lotka 1922). Charles Darwin's theory of survival of the fittest is an example of the maximum power principle when the system or subsystem under study is a living organism. An industrial example would be competition between two factories producing the same product; one only used wood as an energy source whereas the other used wood and coal.

ENERGY QUALITY

In assessing the capacity of energy to do work, more must be known than the total amount of available heat equivalent energy. This requirement can be illustrated by comparing wood and coal as fuels. Coal is a higher quality (more concentrated) fuel than wood. For example, it is more desirable to fuel a foundry with coal than wood because the more concentrated coal burns at a higher temperature. The difference in the energy quality of wood and coal is

a result of their composition. Coal is basically wood and other organic matter which, over periods of geologic time, has been compressed, heated, and eventually carbonized and has a higher energy quality factor (Table 1). The use of energy circuit modeling to diagram the flows of wood and coal into a foundry process is illustrated in Figure 2. Note the geologic upgrading of wood to coal in the model. The plants are diagrammed as a producer and the foundry as a consumer unit.

Table 1. Energy quality factors for various fuels (Odum and Odum 1976; Alexander et al. 1980b.)

Power Source	Energy Quality Factor (solar cal/cal)
Sun	1
Wood	1,000
Coal	2,000
Oil	3,400
Gas	3,400
Electric Power	8,000

The wood, coal, and oil and gas factors represent estimates of the different quantities of solar energy required to produce these fuels and also give an indication of how much of each will be required in a specific industrial process. The higher the quality factor of a given energy source, the better able it is to do useful work. Consequently, the energy quality factor, compared to solar energy, is the best indicator of the inherent worth of a given energy type. Quality factors provide a way of estimating the value of the natural energies and of comparing them to other types of energy such as those associated with animals, human culture, materials, and information (Odum and Odum 1976). Information in this context refers to the flow of concentrated energy between a sender and receiver as in a radio broadcast or human speech. The flow of information is an example of a very highly concentrated energy flow, i.e., it takes large quantities of solar energy to power systems which in turn produce information flows in a control action.

ENERGY AND MONEY

The interaction of energy and money of a farm is illustrated in Figure 3. In this simplified energy circuit model of a farm, renewable natural energy

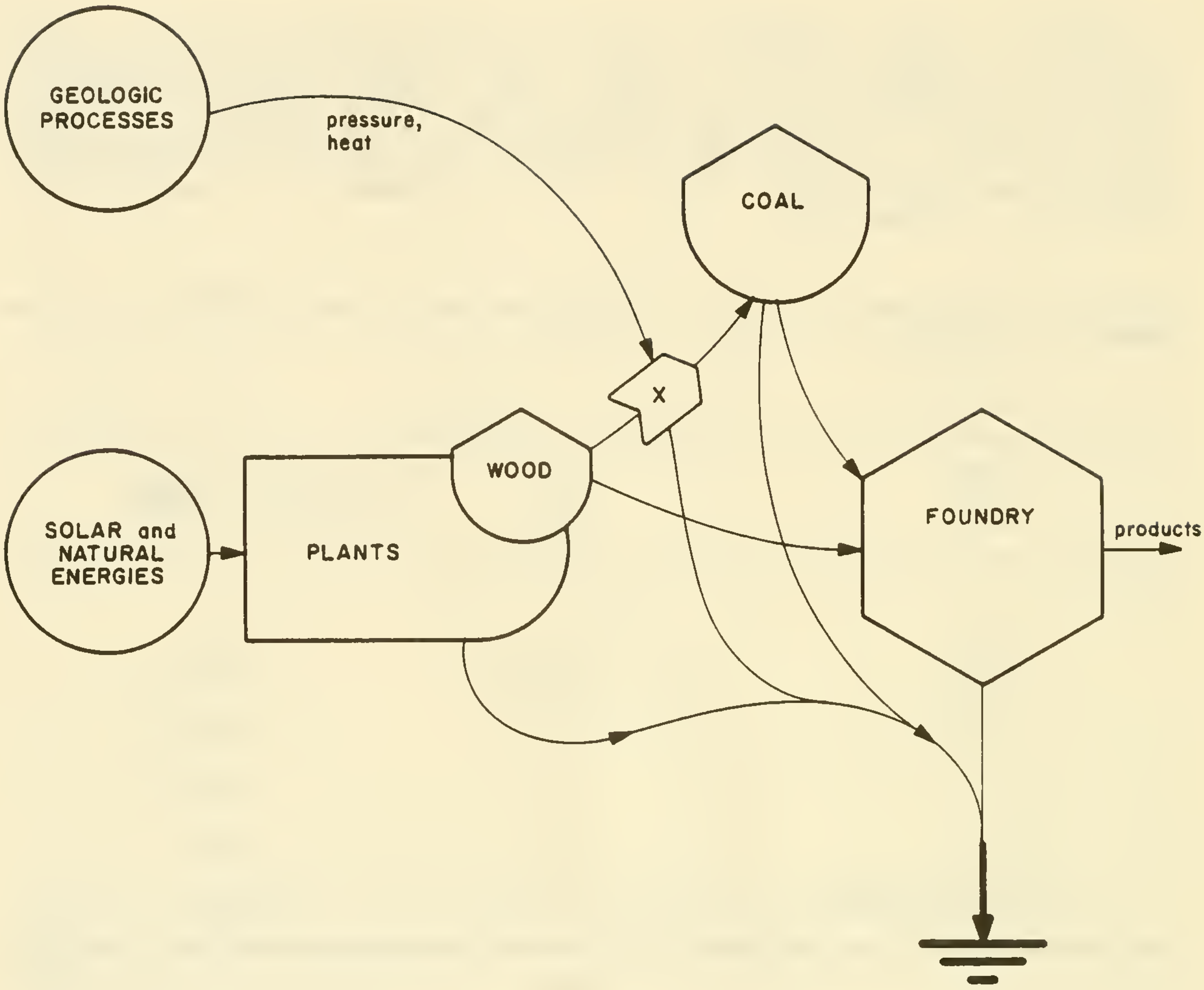


Figure 2. Energy flow model of wood and coal as fuel sources for a foundry.

such as sun, rain, and wind are used to power the crop growing process. The farm production consumer system contains equipment which is used to cultivate the soil and harvest the crop. The harvested crop exported from the farm system produces a flow of money into the farm in a direction opposite to the flow of exported energy. The money derived from the sale of produce is stored in the money storage tank. The stored money consequently is used to purchase fuels, goods, and services necessary to operate the farm.

For any nation, the ratio of dollar flow to energy flow, for a particular year, may be calculated by dividing the sum of all natural and fossil fuel energies entering the nation by the nation's gross national product. For example, in 1975 24.56×10^{15} calories of energy were consumed in the United States, whereas the gross national product was $1{,}526.8 \times 10^{12}$ dollars. This calculation produces an energy to dollar ratio of 16,100 calories per dollar (Figure 4) and shows the ratio of embodied energy flow to gross national

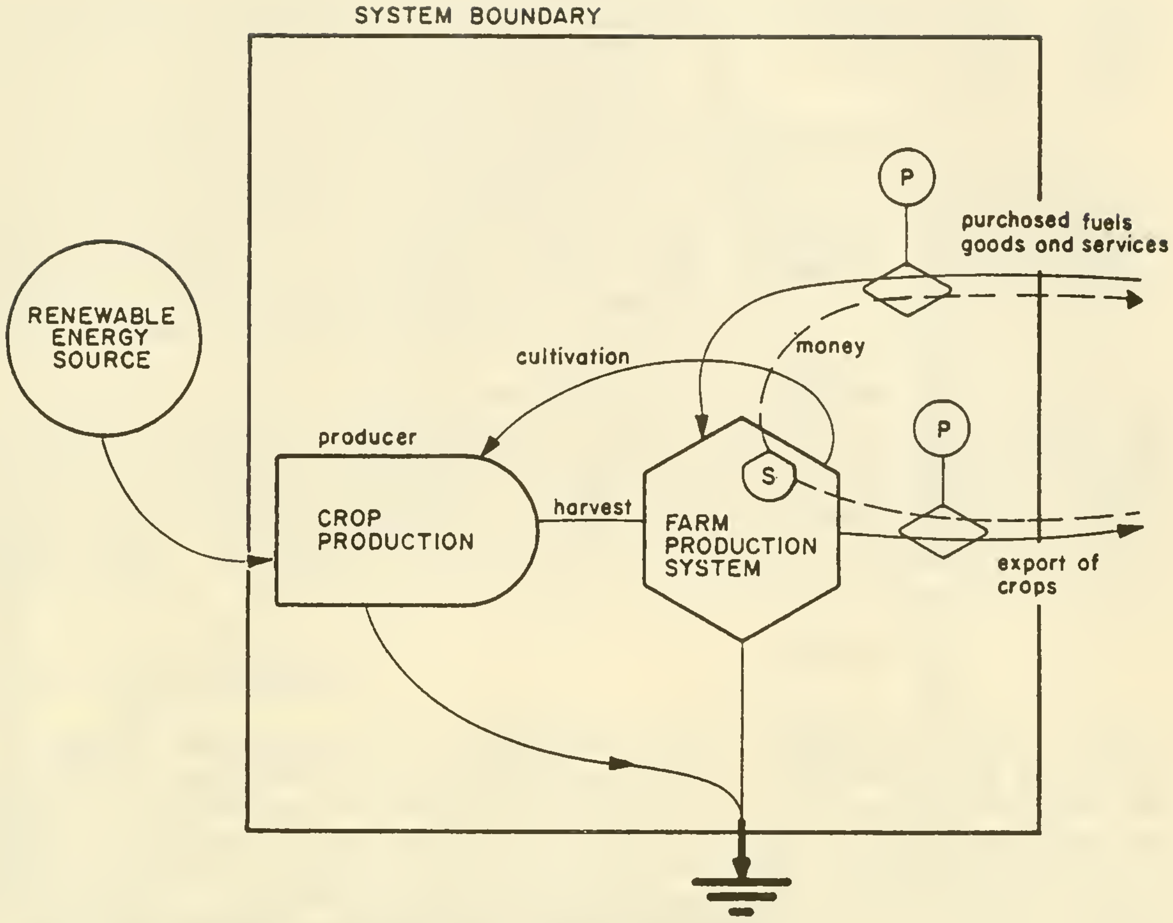


Figure 3. Energetics model of a farm illustrating the interaction of energy and money.

product for 1947-78 according to Odum et al. (1980). Energy to dollar ratios are useful when evaluating urban energy flows because the dollar value of a specific flow such as human labor often is the only data available. The dollar to energy ratio gives an estimate of the quantity of fossil fuel and natural energy required for the United States society to provide a specific function. Note the drop in energy per dollar of the United States gross national product.

One final point to be made concerning the relationship between money and energy is that the quantity of money flowing per unit of energy is constantly changing, as plotted in Figure 4. Non-renewable energy, such as oil, is recovered and processed for further use by human consumers. The consumers pay the energy processors for providing the service. As the more easily recovered fuels are expended, more energy must be used to recover the less accessible fuels. The result is that the same expenditure of energy, measured in terms of money, produces less usable energy, which causes inflation. Government policies which expand the national money supply also contribute to the declining energy to dollar ratio. When using money flows to estimate energy flows, the money-to-energy ratio will be dependent on the year that the data were

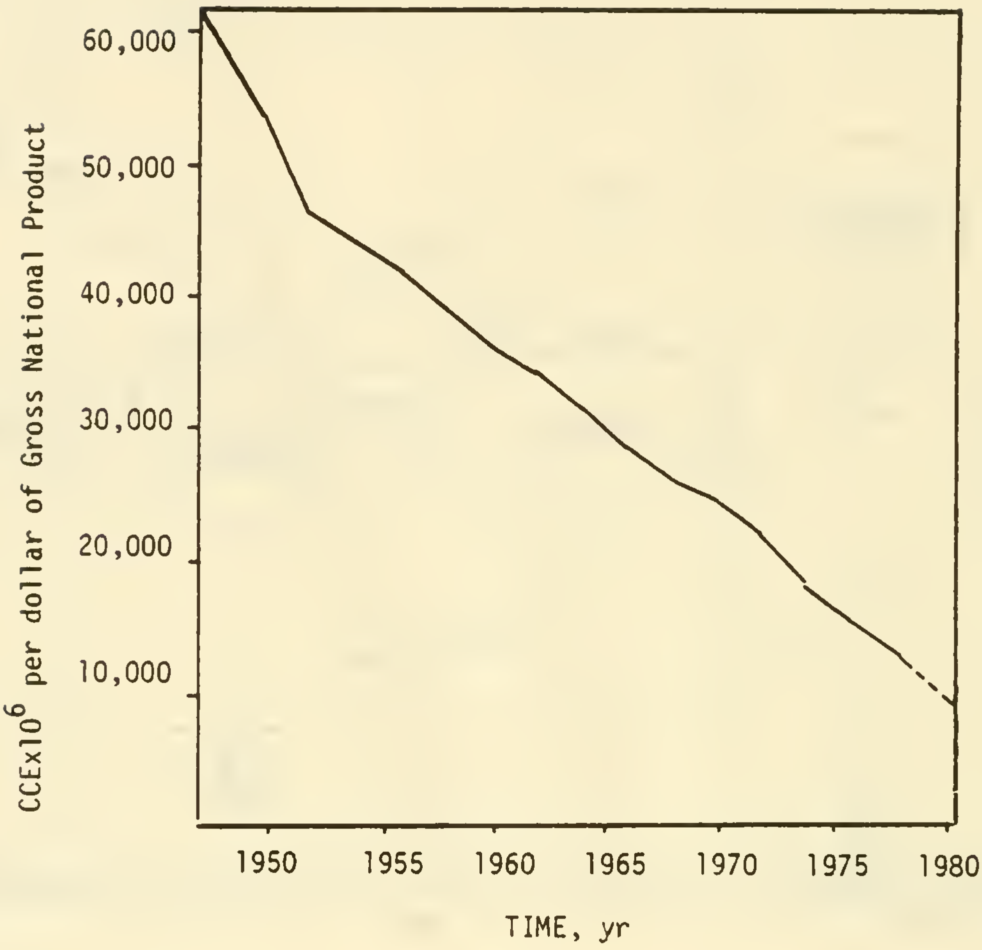


Figure 4. Coal equivalent calories per dollar of gross national product per year.

collected, because the cost of energy has been increasing steadily in recent years.

ENERGETICS MODELING METHODS

Step procedures for developing energetics models of socioeconomic and environmental systems are described in this section.

STEP 1: ECOLOGICAL SYSTEMS MAPPING

The important first step in the design of an energetics model is the identification of all principal natural and man-made systems. Each vegetative

cover type must be located and identified with sufficient precision to permit its area to be measured or reasonably estimated. Although areas of human activity also should be recorded, the energy human systems consume will be measured by using social and economic data as well as the area they occupy.

Land-use maps are a particularly good source of information but some exhibit serious deficiencies. Although land-use maps provide minute detail on human activities, the ecological systems that are not human-intensive are frequently aggregated into categories which are not suitable for the development of energetics models. For example, tidal marsh, mangroves, and other wetland vegetation types are frequently shown as some catch-all category such as "wet" land, or, worse, "idle" or "vacant" land.

This step produces a map of energy producers and users and the relative areas occupied by each. From this information, the energy flows of the natural systems can be calculated for the region. Unlike natural systems, the energy flows for areas of intensive human activity do not have their energy flows calculated from their total area, but instead use other measures of economic activity. Methods for calculating the respective energy flows are discussed in Step 3.

STEP 2: SYSTEMS BOUNDARIES

A systems boundary must be established by the researcher at the initial stages of the development of an energetics model. The boundary of the system is usually dictated by the purpose of the model. It is very helpful when the flow of energy across a boundary is minimized because energy flow across any boundary, as well as those within the system, must be carefully itemized. In many situations, the information necessary for the energetics model can be more easily collected and evaluated if significant natural systems are not divided. For example, a study for the National Park Service of the Redwood National Park (Alexander et al. 1980a) used county lines as system boundaries after the redwood habitat was mapped and found to be generally located within two adjacent counties. In other energetics modeling situations, counties or other political boundaries that may form an appropriate boundary seldom occur. Most frequently, the decision to use political boundaries, such as county lines, increases the difficulty of measuring natural systems. In the example given in this paper, a model of the City of Tampa would have many more significant flows across the city limits than would be necessary for a model of Hillsborough County, Florida, simply because a large portion of Tampa's labor force lives in the urban area surrounding the city but are largely contained in Hillsborough County.

STEP 3: IDENTIFICATION OF ENERGY FLOWS ACROSS THE SYSTEM BOUNDARY

Once the system boundary is defined, flows of energy into and out of the system can be identified. Normally these flows include solar energy in the form of sun, rain, and wind; fossil fuel energy in the form of electricity, petroleum, goods and services, and information; combinations of solar and fossil fuel energy in the form of people; and money.

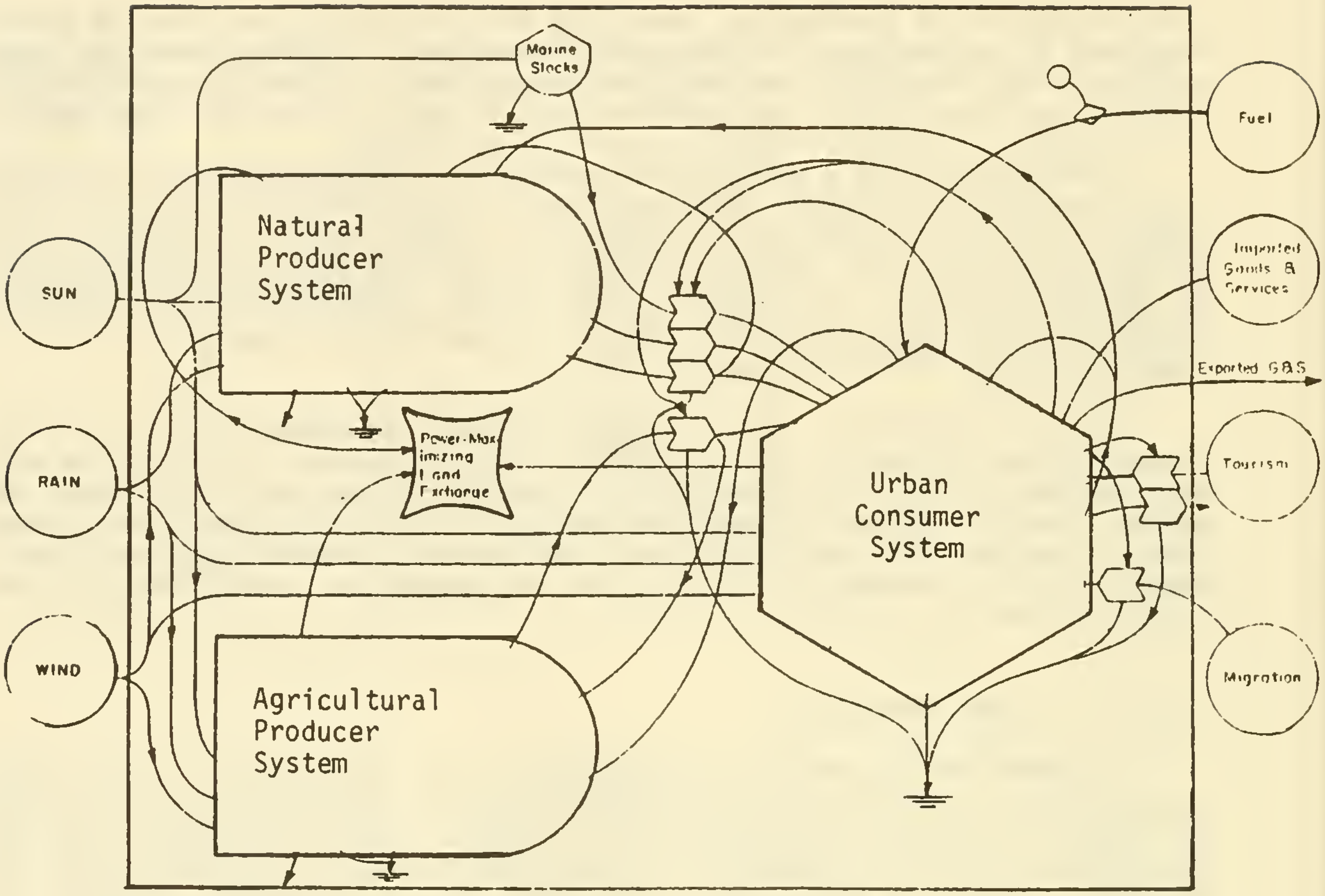


Figure 5. Basic Hillsborough County model.

This step in the modeling process is fulfilled by drawing a large rectangle around the system. The flows of energy across the boundary are represented as energy sources (circles, Step 2). The more dilute energy sources such as the sun, wind, and rain are customarily located in the lower left of the rectangle, whereas the more concentrated sources such as fossil fuel, petroleum, and information are shown on the top or right side of the rectangle. The energy quality increases from left to right.

STEP 4: IDENTIFICATION OF THE PRINCIPAL SUBSYSTEMS WITHIN THE SYSTEM

In the example of Hillsborough County, both natural and agricultural subsystems are shown (Figure 5). If agriculture were relatively unimportant, it might logically be included with the energy flows of the natural subsystem component. Examples of natural systems are estuaries, ponds, tropical forests, or grass prairies. The distinction between natural and agricultural systems is that natural systems are self-organizing and self-maintaining whereas agricultural systems require maintenance and organization. The important balance is to include all necessary detail in the energetics simulation without including detail of unnecessary subsystems. The identification of the subsystems to be modeled is dependent on the goals of the research

project, because the questions to be answered by the simulation determine the detail reflected in the systems components (Figure 5).

STEP 5: IDENTIFICATION OF INTERACTIONS BETWEEN SUBSYSTEMS AND SOURCES

In the Hillsborough County example (Figure 5), interactions between the subsystems and sources are shown by energy flow pathways. A matrix may be helpful to systematically identify these flows. The energy sources with internal sources such as the output of the urban system followed by the external sources in order of increasing energy concentration are listed on the vertical axis. The internal energy sinks followed by the external sinks are listed on the horizontal axis. An agricultural production unit is an example of an internal sink. Once the input/output matrix is completed an "X" may be used to indicate a significant energy flow pathway. The completed matrix now forms a guide to the necessary energy flow pathways to diagram the system, i.e., one energy flow pathway on the model will be represented by one "X" in the input/output matrix. If each energy flow in the input/output matrix was evaluated and the corresponding energy flow quantity used to replace the "X" in the matrix, an energy input/output model would result. For researchers familiar with economic input/output models, this may be a familiar arrangement with which to work.

STEP 6: ENERGY FLOWS WITHIN THE SUBSYSTEMS

A researcher can incorporate more detail into the model by further examining energy flows within individual system components. For example, Figure 6 shows the system detail for the production systems. Farms, salt marshes, and forests are typical production systems. The "producer" system shown by the bullet-shaped symbol contains a storage tank, which is an energy accumulator, or "counting" device and a feedback loop.

Once all subsystem diagrams showing energy flows and storages are completed, the energetics model is complete. The actual flows in the model must now be measured or calculated. To facilitate this, each flow pathway and storage symbol is assigned a unique identifier. These identifiers for a natural subsystem model, such as a forest, are shown in Figure 6.

STEP 7: EVALUATION OF THE ENERGETICS MODEL

Each storage and flow of energy identified in the previously drawn energetics diagram must now be quantified, or evaluated, as the quantification process is also called. The evaluation of the model can be done at a broad level, but it is much simpler to undertake this step at the subsystem level because the interdisciplinary nature of systems tends to make model evaluation difficult. Evaluation of energy flows and storages in the natural system can be based on information found in ecological literature (Lieth and Whittaker 1975), just as information on agricultural systems can be found in the agricultural literature. All flows of energy must adhere to the laws of thermodynamics. That is, energy may not be created or destroyed in any process, and

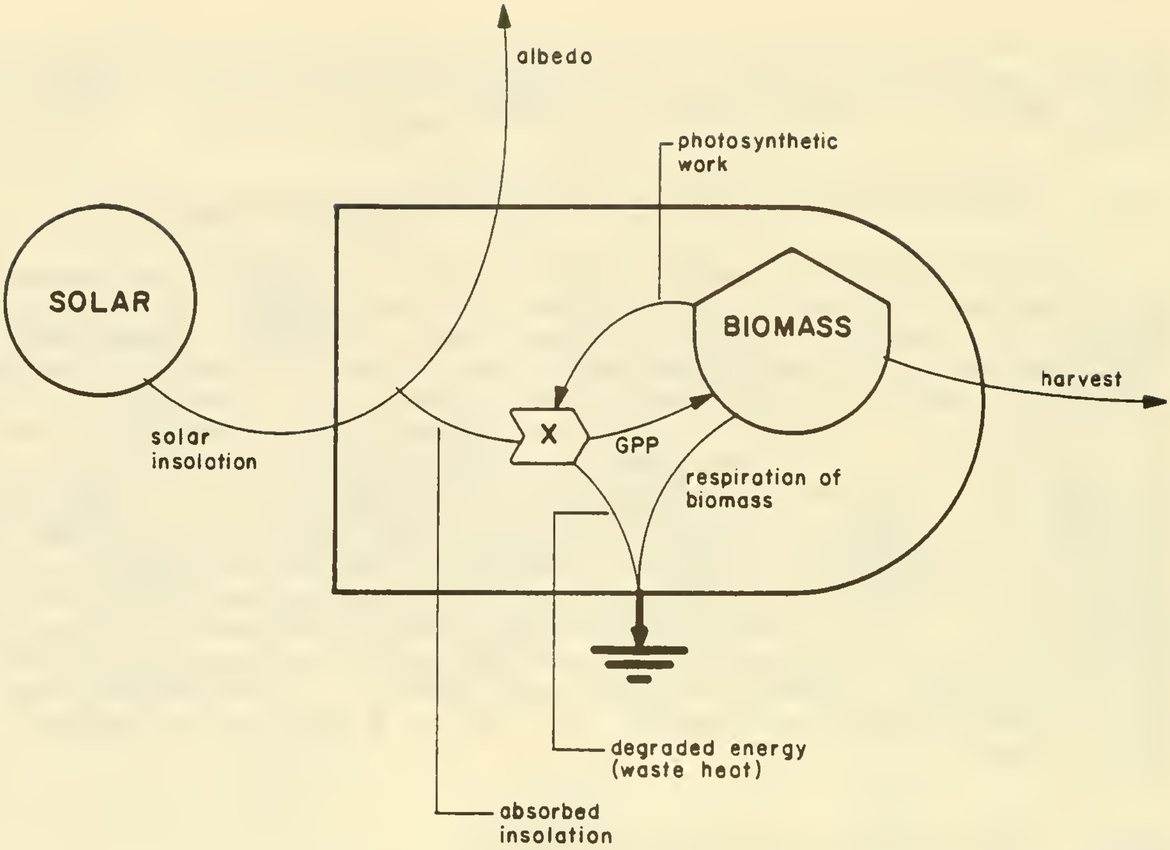


Figure 6. Simplified subsystem model of Hillsborough County natural production system.

some energy must be degraded in any real process. The first law states that the sum of the flows into and out of any interaction must be equal, whereas the second law or principle requires all interactions must have heat sinks for losses of unusable degraded energy. A separate evaluation should be set up for each of the subsystems being studied. It is necessary to include in this table all storages and flows of energy identified on the systems diagram prepared earlier. It is also necessary to document the calculations and relevant references for each of the flows and storages.

Figure 7 is an example of the results of evaluating the natural production system shown in Figure 6. The area of each natural ecosystem in the county was obtained from a 1978 map of Hillsborough County, Florida (Hillsborough County Environmental Protection Commision 1979). The solar insolation of a natural system was calculated by multiplying the solar insolation for Hillsborough County (1.5×10^6 cal/m^2/yr) by the land area of the natural system (1.23×10^8 m^2) yielding a total solar insolation of 1.84×10^{14} cal/yr. Eighty-six percent of the solar energy (1.6×10^{14} cal/yr) is absorbed leaving an albedo (reflection) of 14% (2.6×10^{13} cal/yr).

Next the energy stored in the biomass of Hillsborough County's natural system is calculated (see Table 2). The land area of each ecosystem is multi-

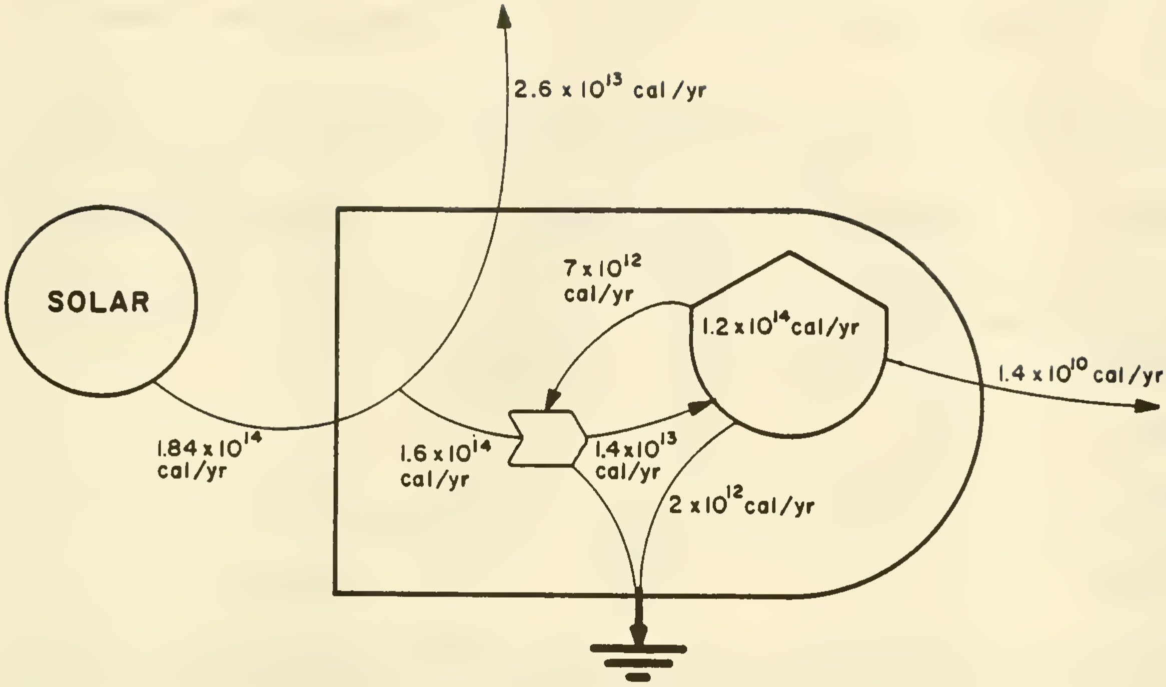


Figure 7. An evaluated model of the Hillsborough County natural system (see Figure 6 for energy flow pathway names).

plied by the mean weight of the particular ecosystem biomass. The energy stored in the biomass is computed by multiplying the cal/g of biomass dry weight by 4.25. The total energy stored in the biomass is computed by summing the individual ecosystem energy storage values. Similarly, the gross primary production of the boundaries area is computed and then summed. This is also illustrated by Table 2. Our experience has shown that splitting gross primary production equally between the work required for respiration and photosynthesis is a good first estimate.

The energy value of the harvest from the natural system was computed by multiplying the dollar value of the stumpage (total volume of wood harvested, i.e., 8.7×10^5) from Hillsborough County's natural system by the 1978 energy to dollar ratio from Figure 4 (1.6×10^4 cal/\$) yielding 1.4×10^{10} cal/yr. The harvest is small when compared to the total energy stored in the natural system.

STEP 8: TRANSLATION OF ENERGETICS DIAGRAMS TO DIFFERENTIAL EQUATIONS

An energetics diagram is actually a differential equation in a pictorial form. Figure 8 is an example of an energy circuit model with its corresponding differential equation. The storage symbol in the diagram represents the equation state variable. The rate of change of the storage of energy is calculated by summing of all of the flows of energy into and out of the storage. Energy flows leaving the storage are given a minus sign. The differential equation for the natural system of Hillsborough County is given in Figure 8.

Table 2. Primary productivity estimates for Hillsborough County natural systems

Systems	Land area[a]	Biomass[b]		Gross primary productivity[b]	
	m^2	Kg/m^2	Cal	$Cal/m^2/yr$	Cal/yr
Pineland	1.8×10^8	35	4.2×10^{13}	1×10^4	2.8×10^{12}
Hammock	3.9×10^8	35	5.8×10^{13}	1.3×10^4	5.1×10^{12}
Cypress	1.1×10^8	35	1.6×10^{13}	1.3×10^4	1.4×10^{12}
Marsh and Slough	5.6×10^7	15	3.6×10^{12}	2.4×10^4	1.3×10^{12}
Mangroves	2.8×10^8	1	1.2×10^{12}	1.2×10^4	3.4×10^{12}
Lakes and Ponds	5.6×10^7	0.02	4.8×10^9	3.2×10^3	1.8×10^{11}
Scrub	5.6×10^7	1.6	3.8×10^{11}	4.8×10^3	2.7×10^{11}
	12.3×10^8		1.2×10^{14}		1.4×10^{13}

[a]Hillsborough County Environmental Protection Commission 1979.
[b]Lieth and Whittaker 1975.

Similarly, the research would continue through the entire energetics diagram, translating each storage into its appropriate mathematical analog. Each term in the differential equation represents a specific energy flow in the model. The initial value of the energy flows and storages are used to calculate the pathway coefficients in the equation. For example, the flow of energy on pathway k_4N is 7×10^{12} cal/yr (from Figure 7) thus:

$$7 \times 10^{12} = k_4N$$

$$\therefore k_4 = 5.83 \times 10^2$$

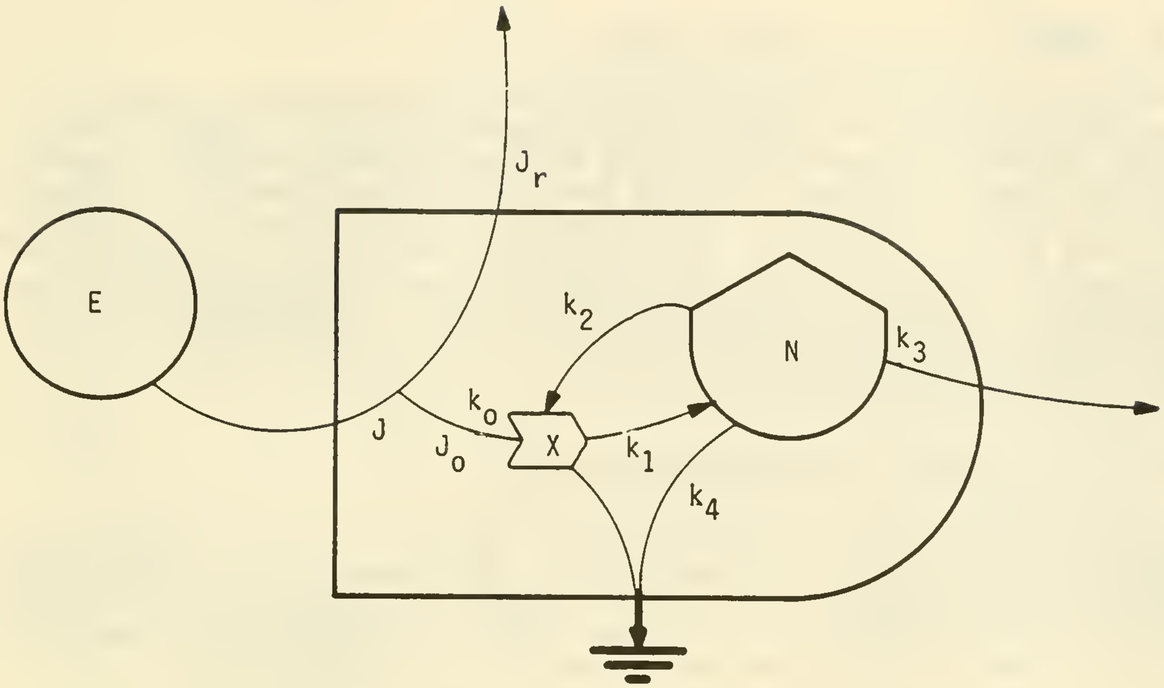


Figure 8. Energetics model of Hillsborough County natural system illustrating the translation of the model into differential equation form.

$$N = (k_1-k_2)J_rN-k_3N-k_4N = \text{differential equation for N}$$

where

E = Energy source (solar, rain, and wind)

N = natural biomass

k_n = energy flow coefficients

J = inflow of energy (solar insolation)

J_r = energy not used (albedo)

J_o = energy absorbed by system (absorbed insolation)

$J = J_r + J_o$ = conservation of energy

$J_o = k_oJ_rN$

$\therefore J = J_r + k_oNJ_r$

$$\dot{N} = \frac{(k_1 + k_2)}{1+k_oN} JN=k_3N-k_4N$$

STEP 9: SIMULATION OF THE ENERGETICS MODEL

With the revolution in computer technology, it became more feasible for the average researcher to simulate simultaneous solution of complex sets of nonlinear differential equations such as one encounters in energetics models. The two most popular simulation methods are: (1) the development of analogous electrical circuits through the use of computer, and (2) numerical approximation using a digital computer. Each of these two methods has advantages and disadvantages, but because digital computers are more frequently available to the researcher, numerical approximation is the method more commonly employed. A more detailed discussion of the simulation process is incorporated into the "Results" section in Step 10.

STEP 10: VALIDATION OF THE ENERGETICS MODEL

There is no specific test to establish the validity of any large-scale simulation model. Correlation analysis and other statistical methods have been used by some researchers to compare similarities between the behavior of the model and the behavior of the system itself as it functions in reality; however, the results of these methods of analysis are inconclusive.

Sensitivity analysis is helpful in validating large-scale simulation models. Individual pathway coefficients are varied to test the system's sensitivity of changes in the linkages. Sensitivity analysis is often helpful in finding errors in the model design or construction when unexpected behavior occurs.

Other attempts at validating energetics simulation results are: (1) to use historical data in the mode, simulating a period from the initial time to the present, allowing simulation results to be compared with currently available empirical data; (2) in cases where the system being simulated is relatively well understood, comparing the simulation results to known system behavior can assist in the validation of a given energetics model. For example, the researcher might be interested in changes in the simulation results as different variables are changed to reflect the impact of hypothetical future actions and events.

RESULTS OF ENERGETICS MODELS

INTRODUCTION TO HILLSBOROUGH COUNTY MODEL

In illustrating the methodology for preparing an energetics simulation, as was done previously in this report, a simple example was used. In this section, a more complex model is considered, one that has been used to illustrate energy alternatives to public administrators.

The earlier model (Figure 5), and the one prepared for this section (Figure 9), share the same structure incorporating "natural," "agricultural," and "human" subsystems. The results discussed in this section are of this expanded model.

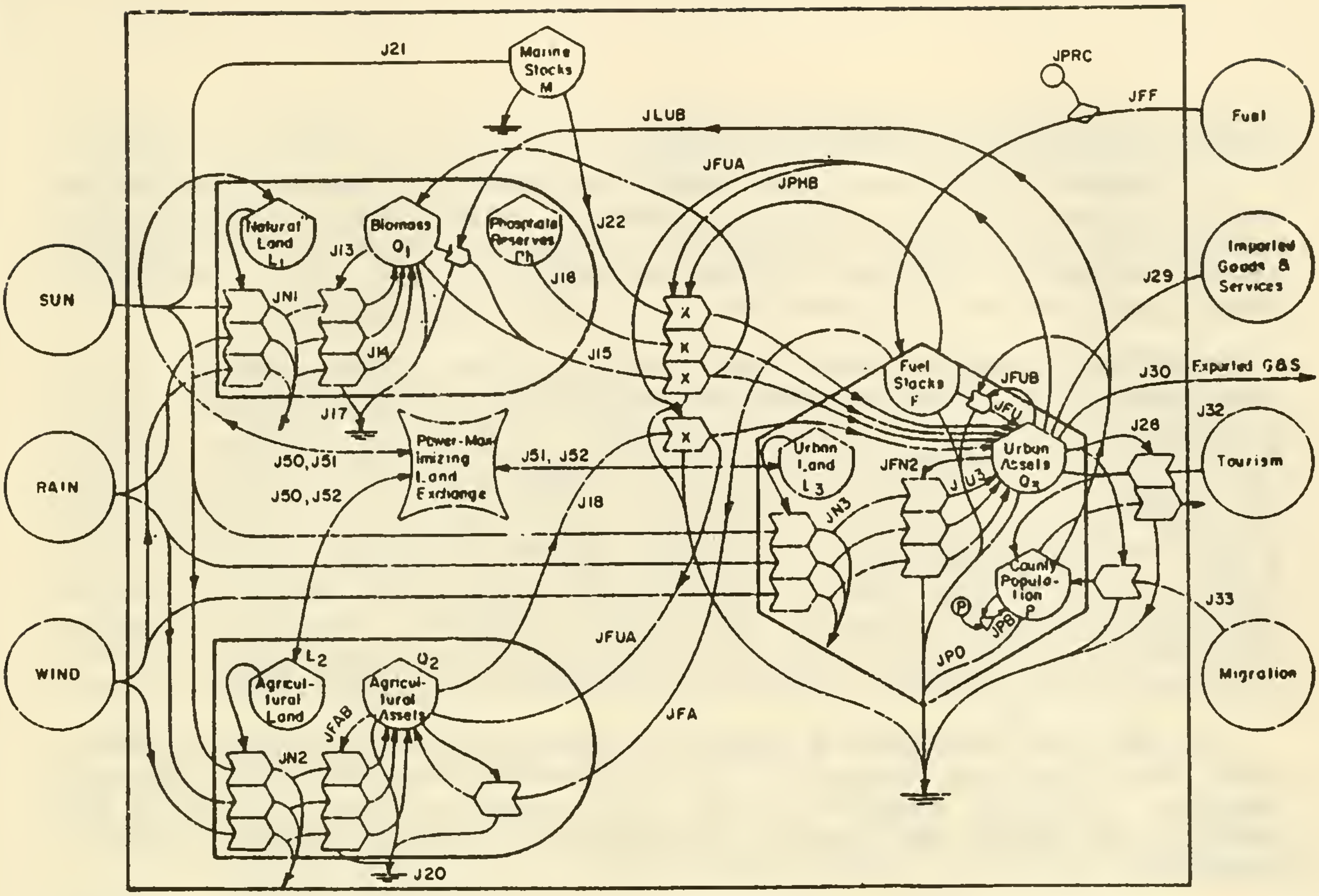


Figure 9. Detailed energy model of Hillsborough County (Sipe et al. 1979).

The energy circuit model of Hillsborough County, used as an example in this section, was developed as part of the Energy Basis of the Hillsborough County Project at the Center for Wetlands, University of Florida, sponsored by the Hillsborough County Environmental Protection Agency, John F. Alexander, Jr., and H. T. Odum, principal investigators. The simulation model was developed as part of the project by Dennis Swaney and report by Sipe, Swaney, and McGinty (1979).

Description of the Region

Hillsborough County, Florida, near the center of the west coast of Florida, is almost square in shape, about 36 miles along each side. The total area of 1,235 mi^2, is slightly larger than that of the State of Rhode Island.

The county is relatively flat, elevations range from sea level to a high of 49 m (165 ft) in the eastern part of the county. The four principal natural regions of the county are sandhill highlands, inland flatwoods, coastal lowlands, and river valleys. The county has a subtropical climate, mild winters (average January temperature, 15°C or 59°F) and warm humid summers (average August temperature, 20°C or 82°F).

Overview of the Hillsborough County Model

In research situations, each energetics model must be tailored to the particular application at hand; each energetics model incorporates its unique features into the design. Although it is beyond the scope of this report to examine in detail all facets of the Hillsborough County model, some of the more salient features are summarized in the following paragraphs.

One such feature is the "Power Maximizing Land Exchange," shown as the four-cornered logic module in the approximate center of the diagram. It redistributes land between the three subsystems. Hillsborough County, like many Florida coastal counties, has a rapidly increasing population. This increase has brought about a conversion of some of the natural and agricultural lands to urban lands, as the City of Tampa and its surrounding communities have grown. The model exchanges land between the three sectors according to the relative value of the change in gross county energy flow, just as in actual land changes between sectors as land becomes economically feasible to develop (or preserve) within a subsystem. Land exchange is important because the natural energy flows into each subsystem are proportional to the total land area.

In addition to monitoring changes in land areas, the Hillsborough County model also simulates changes in the marine environment and in phosphate reserves. Both are important to the local economy and were included in the model to show county administrators the effect of different scenarios on these resources.

Another feature of this particular model is the fuel price monitor in the upper right-hand corner of the diagram. (It is represented by the small circle and diamond.) As the price of fuel increases, the rate of fuel imported per unit of exported goods and services declines. This allows the effects of fuel increases to be simulated. "What if" scenarios, such as "What if the price of fuel doubles?" can be examined using this feature and can be compared with the results of alternative scenarios.

A summary of the synthesis of socioeconomic and natural system data (Tables 3 and 4) was made by evaluating the energy flows and storages in the Hillsborough County model (Figure 9).

Results of Energetics Simulations

The results of the Hillsborough County energetics simulation are shown in Figure 10. Using 1948 data, the model simulated historical changes in the land area of each subsystem and of population for the county. The values obtained by the simulation closely paralleled the actual data available for 1978. (Although the oil embargo of 1972 did affect energy flows in each subsystem of the county, the effects on land area and population were small in comparison to changes in 1948.) Although the rate of conversion slowed when the simulation was continued into the future, the historical trend of land in the natural subsystem being converted into urban and agricultural land continued (Figure 10). This simulation was predicated on the assumption that fossil fuel, such as oil, coal, and natural gas would continue to be available through the end of the century, but it included a sudden price jump in 1973 for these fuels to reflect world events as they occurred.

Table 3. Synthesis of 1975 socioeconomic and natural system energy storage data for Hillsborough County (Sipe et al. 1979).

Storage	Description and value
L1	Total land in natural systems of Hillsborough County = 7.781×10^8 m (Hillsborough County Environmental Protection Commission 1979)
Q1	Total biomass of natural systems of Hillsborough County = 1.94×10^{13} Kg = 8×10^{13} cal (Lieth and Whittaker 1975)
Ph	Total phosphate reserves currently estimated to exist in Hillsborough County = 2×10^8 short tons = 1.81×10^{11} Kg
L2	Total land in farms for Hillsborough County = 1.445×10^9 m^2 (Hillsborough County Environmental Protection Commission 1979)
Q2	Embodied energy value of farm assets = 1.008×10^{13} cal (Florida Department of Revenue 1976)
L3	Total land area of human systems (e.g., urban, industrial, residential) = 5.558×10^8 m^2 (Hillsborough County Environmental Protection Commission 1979)
Q3	Embodied energy of total assessed value of land and buildings of Hillsborough County 1974 (less agricultural assets) = 1.18×10^{14} cal (U.S. Department of Agriculture 1977)
P	Population of Hillsborough County in 1974 = 5.87×10^5 people (Bureau of Economic and Business Research 1975)
F	Energy value of Hillsborough County Fuel Stocks (1 year of storage = 3.87×10^{13} Cal)
M	Total primary productivity in local marine ecosystem = 4.1×10^{12} cal (Lieth and Whittaker 1975)

Simulation of Alternative Futures for Hillsborough County

Energetics simulations not only provide information on the future impact of current trends, but also permit alternative scenarios to be simulated. In the case of the Hillsborough County simulation, several alternative scenarios were investigated. One assumed that fossil fuel prices would be governed by an increasing "surcharge" starting in 1973, not just a single price increase. The results of this simulation, shown in Figure 11, show a decrease in urban assets to levels of the 1950's. (The data shown in Figure 11, with the exception of population, are in coal equivalent calories.) The decline in urban assets reflects a changing standard of living in Hillsborough County brought

Table 4. Synthesis of 1975 socioeconomic and natural system energy flow data for Hillsborough County (all energy flows in 10^{10} caloric coal equivalent per year) (Sipe et al. 1979)

Flow	Description
JNI	Sum of climatic energies available to natural ecosystems (sun, rain, wind) = 312.9 (Swaney 1978)
JN2	Sum of climatic energies available to agro-ecosystems (sun, rain, wind) = 581.0 (Swaney 1978)
JN3	Sum of climatic energies available to urban systems (sun, rain, wind) = 224.4 (Swaney 1978)
JFF	Total fossil fuel input to county functions = 3,677.0 (U.S. Department of Agriculture 1977)
JPRC	Price function of fuel, which regulated fuel input to the county
JFA	Fossil fuel input to agriculture = JFF-JFU-JFD = 3,671.0 (Florida State Energy Office 1978a, 1978b; Tampa Electric Company 1976)
JFD	Annual depreciation of fuel stocks = 77
J13	Feedback from natural sector stocks to natural sector production = 2,360. 20% of gross primary production (Lieth and Whittaker 1975)
J14	Usuable climatic energy to natural sector = JN1
J15	Input from natural to urban sector = 1.6 (Bureau of Economic and Business Research 1977)
J16	Input from phosphate to urban sector = 326 (Bureau of Economic and Business Research 1977)
J17	Depreciation of natural sector (vertical heat loss) = 124.5 (Swaney 1978)
J18	Input from agriculture to urban sector = 250 (U.S. Department of Agriculture 1977)
J19	Usable climatic energy to agricultural sector = JN2
J20	Depreciation to agricultural section (vertical heat loss) = 231 (Swaney 1978)
J21	Sum of inputs to marine system = 90.4 (Heath and Wimberly 1971)

(Continued)

Table 4. Concluded.

Flow	Description
J22	Input from marine to urban system = 4.1 (Bureau of Economic and Business Research 1977)
J28	Embodied energy invested in tourism = 690 (Bureau of Economic and Business Research 1977)
J29	Embodied energy of imported goods and services = 1,416
J30	Embodied energy of exported goods and services = 1,363
J31	Depreciation of urban sector (vertical heat loss) = 89
J32	Embodied energy subsidy from tourism = 690 (Bureau of Economic and Business Research 1977)
J33	Population growth due to county assets (i.e., migration) = 20,500 people/yr (Bureau of Economic and Business Research 1977)
JPB	Intrinsic county birth rate = 8,100 people/yr (Bureau of Economic and Business Research 1977)
JPD	Intrinsic county death rate = 4,000 people/yr (Bureau of Economic and Business Research 1977)
JFN2	Feedback from urban stocks to urban production = 45
JU3	Usable climatic energy to urban sector = JN3 (Swaney 1978)
JUAB	Feedback from agricultural stocks to agricultural production = 116 (U.S. Department of Agriculture 1977)
JFUB	Feedback from urban sector to fuel system = 387
JPHB	Feedback from urban sector to phosphate production = 65.2
JLUB	Feedback from urban sector to natural sector = 0.16
JFUA	Feedback from urban sector to agricultural sector = 199 (U.S. Department of Agriculture 1977)
J50	Land exchange between natural and agricultural sectors
J51	Land exchange between natural and urban sectors
J52	Land exchange between agricultural and urban sectors

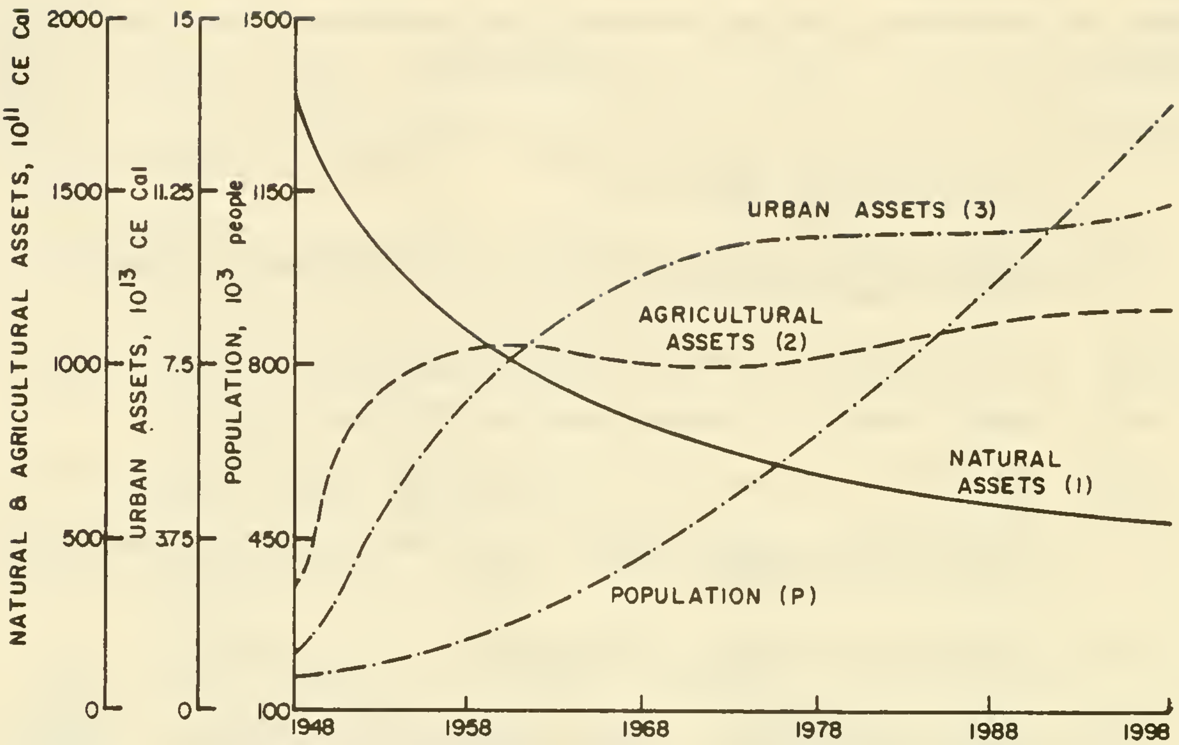


Figure 10. Simulation result of Hillsborough County model with constantly increasing relative imported fuel price and a price jump in 1973 (Sipe et al. 1979).

on by the increased price of fuel, which in turn increased the price of virtually all other goods and services. It not only included the reduced purchasing power of Hillsborough County's exports, but also included, for example, the increased cost of law enforcement and other social services as the county "makes do" with less.

A final simulation considered the impact of a drop in fossil fuel prices due to a hypothetical technological innovation simulated to occur in 1983 (Figure 12). The principal result of this scenario is an increase in the standard of living for residents of Hillsborough County.

Although this particular scenario was assumed to result from a decreased fossil fuel price, the same results would be expected to occur if, for example, there were improvements in fuel efficiency and other energy conservation methods. In the actual study from which these simulations of Hillsborough County were taken, recommendations were made as to which energy conservation techniques, from an energy flow standpoint, showed the greatest promise and how those techniques might best be implemented. These recommendations addressed such subjects as land use, construction techniques, transportation, and others.

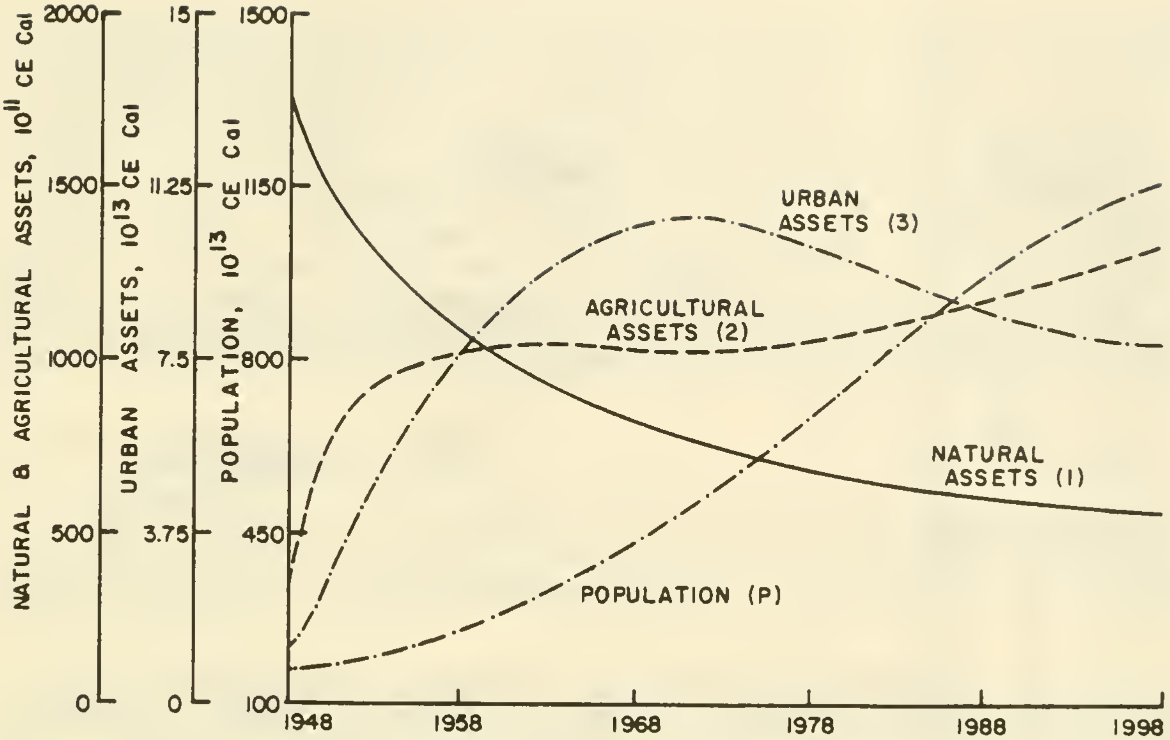


Figure 11. Simulation result of Hillsborough County model with constantly increasing relative fuel prices and a price jump in 1973 with an increasing fuel surcharge beginning in 1973. (Sipe et al. 1979).

USES OF ENERGETICS MODELS

SIMULATIONS

One of the principal uses of energetics models is the simulation of a system from some historical time through the present and into the future. The simulation results of the historical period permit the results of the simulation to the present to be compared with available empirical data. Assuming the simulation performs well in these "benchmark" tests, it is then continued into the future. These simulated results -- telling the researcher of likely trends, given the present and historical data -- are the most common application of energetics models. It is important to know that the simulation results can only be as good as the modeler's ability to comprehend the system under study. Construction of models that reflect actual conditions is difficult.

Frequently, the simulation is prepared to permit the relative advantages and disadvantages of alternative courses of action to be compared. For example, energetics models have been used to examine alternative methods for cooling a proposed nuclear power plant (Odum 1978). This study compared cooling towers, a man-made reservoir, and a nearby lake as possible methods by which the waste heat generated as a by-product of the power generation process could best be returned to the natural environment.

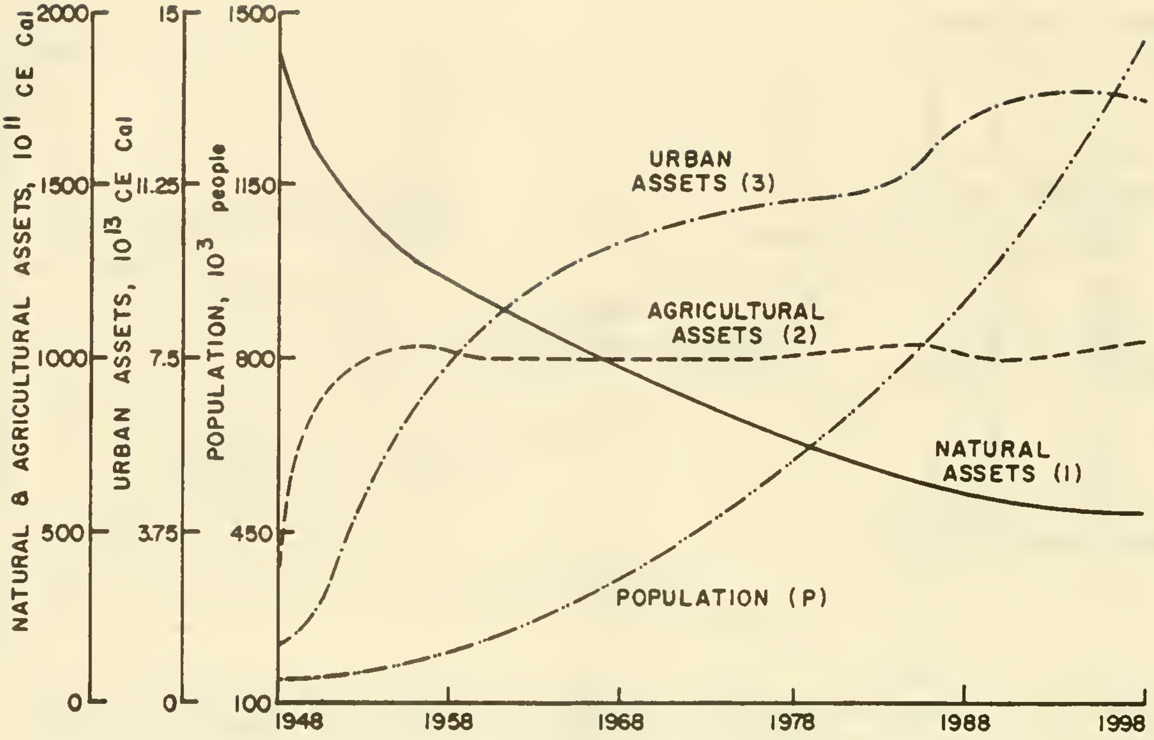


Figure 12. Simulation result of Hillsborough County model with technical innovation such as energy conservation implemented in 1983. (Sipe et al. 1979).

In the Hillsborough County example, comparisons were made between different hypothetical future events that were generally outside the control of the system under study such as changes in world oil prices. Depending upon the likelihood of these hypothetical events, the researcher (or the decisionmaker) may identify other courses of action that minimize any adverse consequences of the outside events. For example, one alternative scenario investigated in the Hillsborough County study assumed that a future technological breakthrough might cause energy prices to fall. Such a technological advance would have numerous beneficial effects on society according to the simulation. The Hillsborough County study also commented that the same simulation results would be expected to occur if, for example, greater efficiency could be attained in the use of presently available energy resources. In this case, Hillsborough County governmental decisionmakers do have methods by which energy conservation measures might be encouraged. And, to the degree these methods improve the efficiency of the system's use of energy, the benefits -- basically, an improved standard of living and quality of life -- suggested by the simulation should be expected to accrue in the system.

Whether or not energetics modeling is a useful research tool, even its proponents admit that the development and simulation of a detailed energetics model is an involved, complex process. There are alternatives to the complete modeling process, however, and, under certain circumstances, these methods are appropriate for comparing specific alternatives.

Basically, the investigation of energy ratios (Figure 13) involves the same methodology but with only a carefully selected portion of one component (or series of components) of an energetics mode. For example, in Figure 14, yield ratios were calculated for electric power plants, by comparing a coal-fired power plant with that of an oil-fired power plant (Alexander et al. 1980b). The output of each hypothetical power plant was held constant at 17.83×10^{12} coal equivalent calories per year (CE Cal/yr). The cost to society to mine and transport the fuel, to build and maintain the physical plant, and the operational costs of the plant are shown as the feedback from the main economy. Comparing these feedbacks to the output of each power plant, respectively, shows the yield ratio. The yield ratio of 12.2 for oil and 5.5 for coal illustrates the economy of oil over coal.

LIMITATIONS OF ENERGETICS MODELS

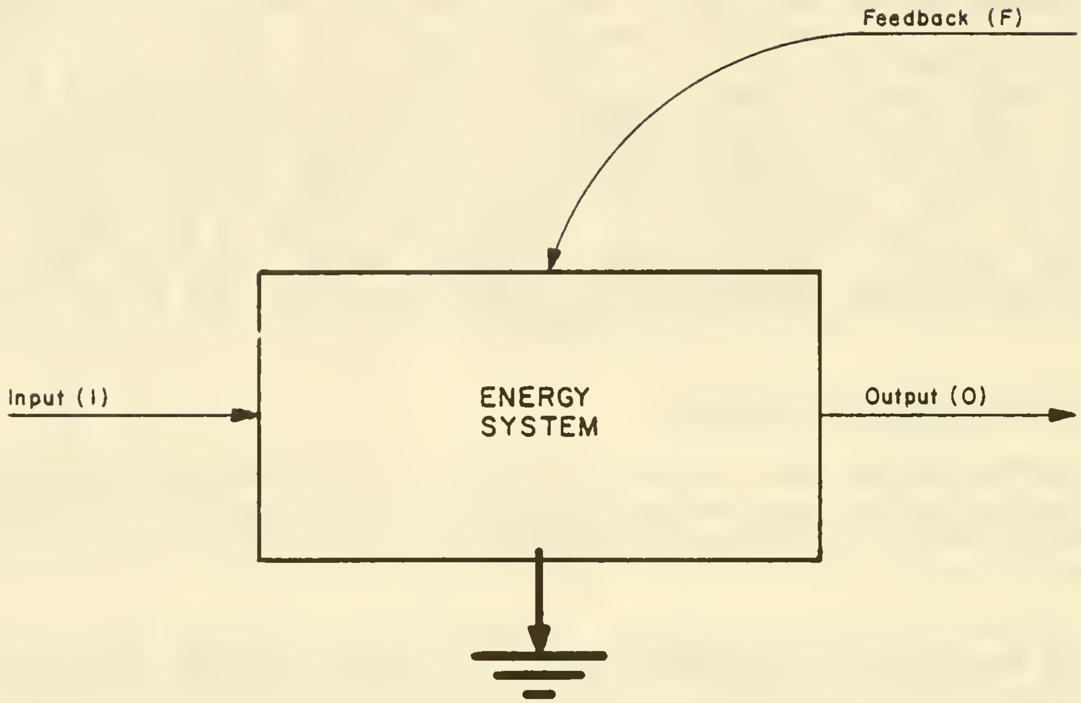
Two limitations that frequently affect the use of energetics models are the frequent lack of appropriate data with which to calibrate the simulation, and the difficulty associated with validation of the results of a particular energetics model.

Collecting the data necessary to estimate the magnitude of each energy flow in the system being studied can be an involved and time-consuming process. Data are seldom usable as found. Mapped data may not include sufficient detail concerning ecological systems, as was mentioned in the methods section. Data from some governmental agencies are often not always compatible with other government agencies. In some cases, traditional methods used by a particular discipline did not permit easy standardization with data expressed in some other unit of measurement. In cases such as these, baseline research must establish appropriate conversion methodologies. This is being done by more and more users.

Closely related to the data-availability problems are the problems associated with validation of the simulation results. If leaders in government and business are to commit their resources to the solutions suggested by energetics models, those leaders must know the degree to which the model is a valid predictor of future systems behavior. Unfortunately, the validation of the results of a particular energetics model applied to a particular problem is difficult.

In addition, theoretical research is producing verifiable data that can in turn be used by any number of future users. The illustration of energy ratios given in Figure 14 is one such example. In it, the researchers established the relative energy quality of wood, numerous coal types, fossil fuels, and other energy sources.

The trend toward a more complex and unified body of knowledge continues. As the body of knowledge surrounding energetics models increases, it will eventually provide a sufficient base allowing for more complex but efficient model simulation.



Net Energy = O - F

Yield Ratio = $\frac{O}{F}$

Investment Ratio = $\frac{F}{I}$

Efficiency Ratio = $\frac{O}{I}$

Figure 13. Energy ratios (Odum and Odum 1976).

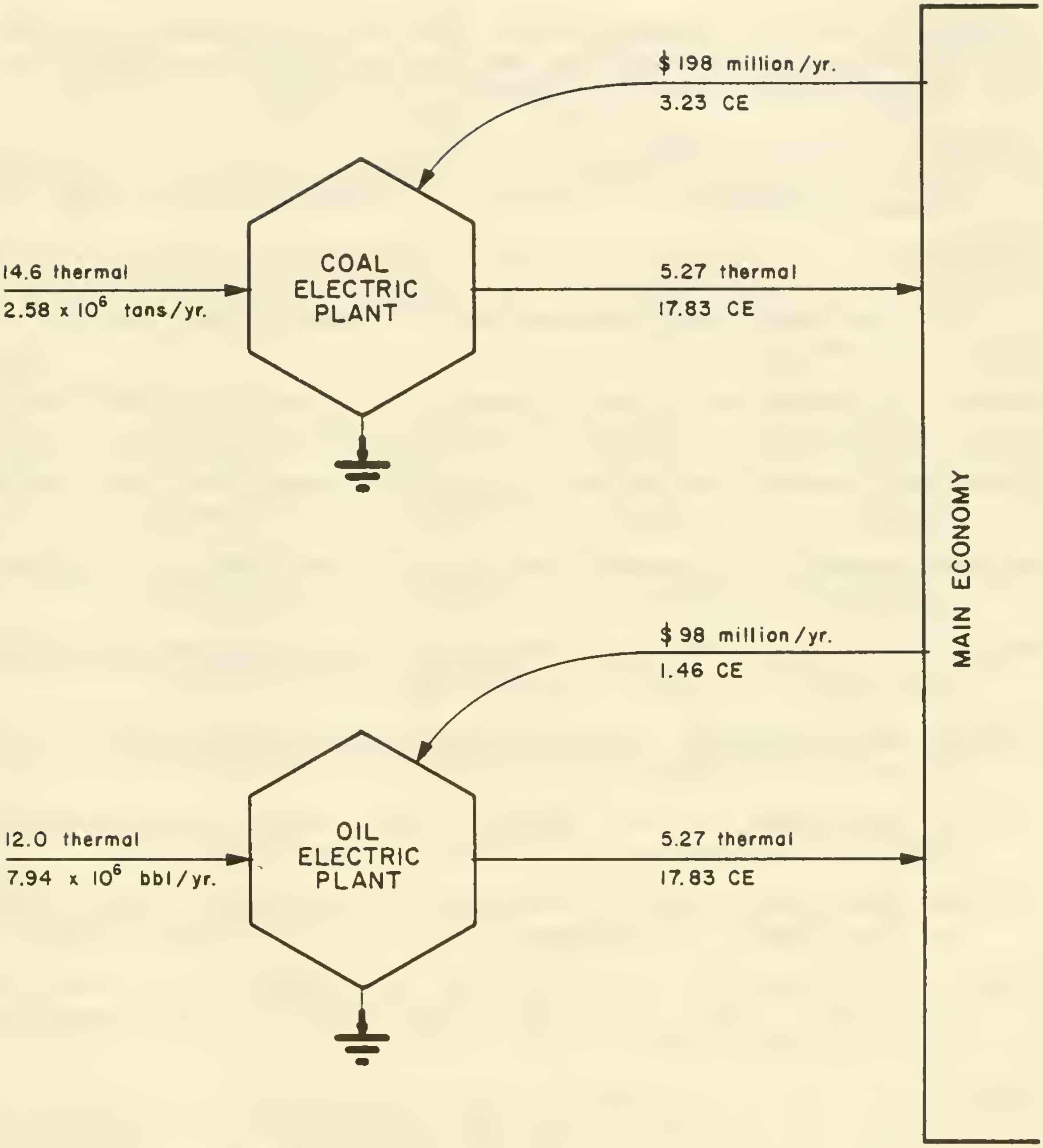


Figure 14. Yield ratios of coal-fired and oil-fired electric power plants (Values are 10^{12} Cal/year unless noted otherwise) (Alexander et al. 1980b).

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50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. FWS/OBS-83/14	2.	3. Recipient's Accession No.

4. Title and Subtitle	5. Report Date
Florida Coastal Ecological Characterization: A Socioeconomic Study of the Southwestern Region	August 1983
	6.
7. Author(s) Carolyn O. French and John W. Parsons (eds.)	8. Performing Organization Rept. No.
9. Performing Organization Name and Address National Coastal Ecosystems Team U.S. Fish and Wildlife Service 1010 Gause Blvd. Slidell, LA 70458	10. Project/Task/Work Unit No. 11. Contract(C) or Grant(G) No. (C) (G)
12. Sponsoring Organization Name and Address Mineral Management Service and U.S. Fish and Wildlife Service Washington, D.C. 20240 Washington, D.C. 20240	13. Type of Report & Period Covered 14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

Data are compiled from existing sources on the social and economic characteristics of the southwestern coastal region of Florida, which is made up of Charlotte, Collier, DeSoto, Hillsborough, Lee, Manatee, Monroe, Pasco, Pinellas, and Sarasota Counties. Described are the components and interrelationships among complex processes that include population and demographics characteristics, mineral production, multiple-use conflicts, recreation and tourism, agricultural production, sport and commercial fishing, transportation, industrial and residential development, and environmental issues and regulations. Energetics models of socioeconomic systems are also presented.

The report consists of one volume of text and three volumes that contain the data appendix.

17. Document Analysis a. Descriptors

Socioeconomic status, demography, land development, fisheries, transportation, models, agriculture, mineral resources, recreation

b. Identifiers/Open-Ended Terms

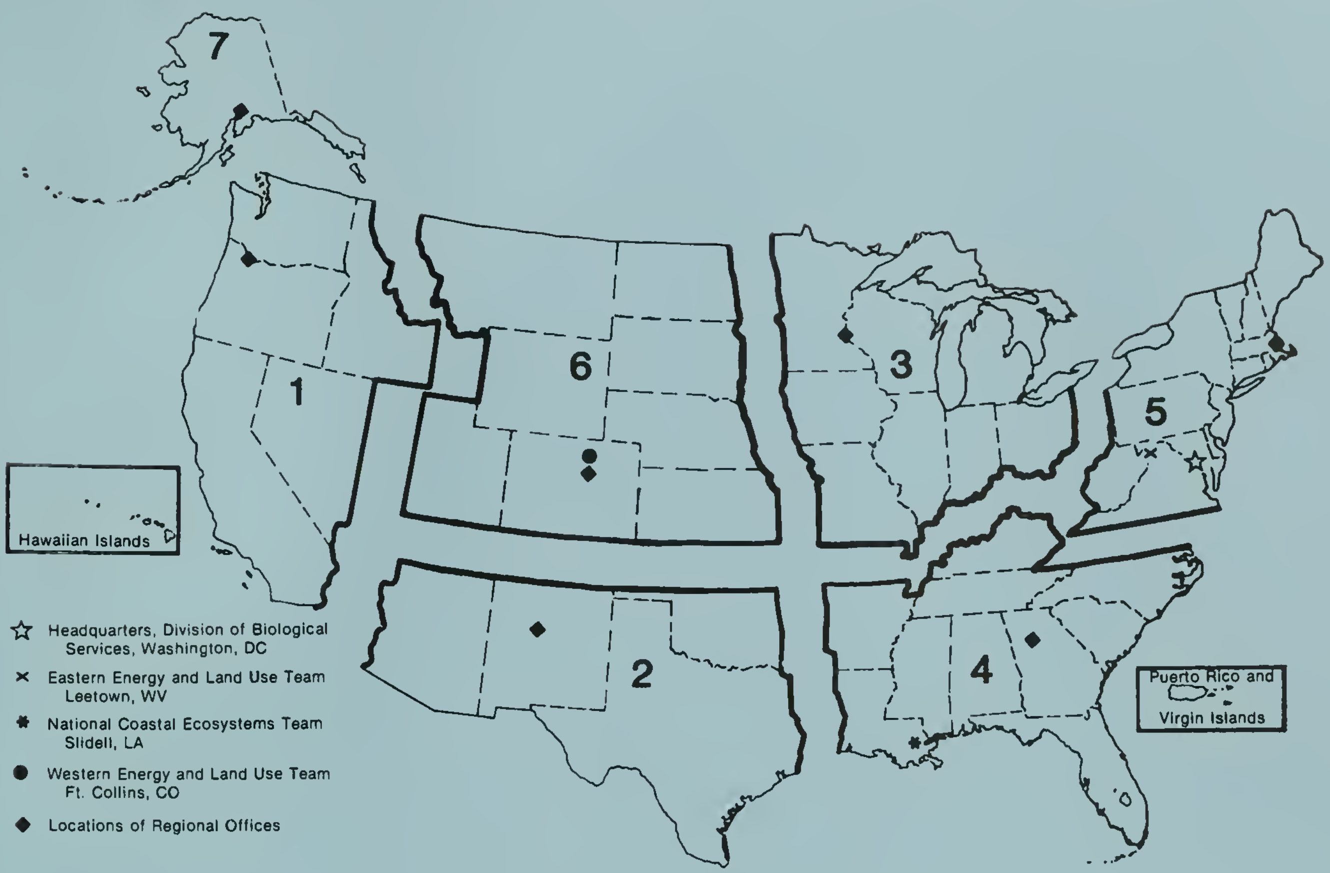
Southwestern Florida

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
Unlimited	Unclassified	333,294,359,195
	20. Security Class (This Page) Unclassified	22. Price

(See ANSI-Z39.18) See Instructions on Reverse OPTIONAL FORM 272 (4-77) (Formerly NTIS-35) Department of Commerce

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983-769-626



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